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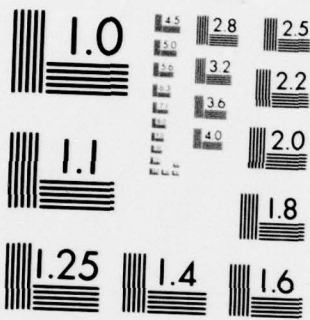
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The general conclusion of this thesis is that the F-5E Aggressor Squadrons should continue as the focal point of enemy tactics, weapon systems and philosophy. Recommendations to improve air combat training and overall tactical force readiness are presented for consideration.

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Will Aggressor Squadrons Be Needed In The Future?

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Final Report 8 June 1979

Approved for public release; distribution unlimited.

A Master of Military Art and Science thesis presented to the faculty  
of the U.S. Army Command and General Staff College, Fort Leavenworth,  
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WILL AGGRESSOR SQUADRONS BE NEEDED IN THE FUTURE?

A thesis presented to the Faculty of the U.S. Army  
Command and General Staff College in partial  
fulfillment of the requirements for the  
degree

MASTER OF MILITARY ART AND SCIENCE

by

BARRY K. WOOD, MAJ, USAF  
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1979

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THESIS APPROVAL PAGE

WILL AGGRESSOR SQUADRONS BE NEEDED IN THE FUTURE?

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

WILL AGGRESSOR SQUADRONS BE NEEDED IN THE FUTURE? by Major Barry K. Wood, USAF, 89 pages.

The U.S. Air Force's poor air combat results in Vietnam prompted more realistic training programs to improve our fighter pilots' air combat effectiveness. The establishment of dissimilar air combat training (DACT) conducted by a professional "aggressor" force has given Tactical Air Command fighter pilots the hostile environment and realistic adversary that were lacking in a predominantly F-4 fighter force. This thesis examined the need for F-5E Aggressor Squadrons to perform this ~~dissimilar air combat~~ role now that the F-15 and F-16 fighter aircraft are in production. The evaluation of Aggressor Squadron operations encompassed both training and cost analyses. The training effectiveness was examined by analyzing Air Force and Navy air combat results in Southeast Asia with and without an Aggressor DACT program and projecting the outcome to a future conflict. The operating costs of the F-4, F-5E, F-15, and F-16 were investigated to determine the most economical vehicle to provide Aggressor training. *The author concludes*

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## CHAPTER I

### INTRODUCTION

The emergence of airpower can certainly be considered one of the most important technological advances of the twentieth century. Differing views on the most effective use of airpower have been expounded by leaders who envisioned airpower to be influential in future conflicts. As early as 1921 General Giulio Douhet, an early protagonist of airpower, stated that "Wars will begin in the air. . . because everyone will be trying to get the advantage of surprise."<sup>1</sup> General Billy Mitchell even made the prediction in 1935 that United States forces in Hawaii would be attacked by Japanese aircraft some unsuspected Sunday morning. His efforts to develop the role of the aircraft as a capable weapons system with massive firepower were not seriously received by Army, Navy, or congressional leaders who could see no enemy air threat toward the United States. This disbelief set the stage for our dramatic entrance into World War II.

"We entered World War II underestimating the importance of air superiority and the difficulty of winning it. We were unprepared both qualitatively and quantitatively."<sup>2</sup> We at least emerged from that conflict with the knowledge that air superiority is essential to the conduct of surface operations.

Achieving or maintaining air superiority in future conflicts depends basically upon our ability to counter two things: enemy



surface-to-air weapons and enemy air-to-air combat fighters. The scopious nature of air superiority is confined in this study to the air-to-air arena. "The outcome of the air-to-air battle for air superiority, and all which that battle determines, depends on four factors: airframe performance, armament effectiveness, pilot proficiency, and numerically adequate fighter forces."<sup>3</sup> This study examines the pilot proficiency or human factor of the superiority equation.

The most important elements that constitute the human factor are professional experience and training. Professional experience is difficult to quantify, but investigation has shown this element to be consequential. The most successful fighter pilot in the history of air fighting, Erich Hartmann, a World War II German pilot, shot down 352 Allied aircraft.<sup>4</sup> Thirty men - the top ten aces of England, Germany, and the United States - accounted for 3,176 air-to-air kills in World War II.<sup>5</sup> In the Korean War, the distribution of 3.2 percent MIG kills by only 4.8 percent of the pilots was attributed primarily to experience.<sup>6</sup> On the other hand, very few pilots enter a conflict with previous combat experience. One study on the combat performance of pilots points out that "fewer than 15% of all pilots had a better than even chance of surviving their first combat."<sup>7</sup> Training, then, becomes an important element of air superiority.

#### OBJECTIVE OF THE STUDY

The objective of this study is to investigate the air-to-air training received by our tactical fighter pilots to determine if there will be a projected requirement for U.S. Air Force Tactical Fighter

Training Aggressor Squadrons in light of the sophisticated weapon systems currently in production.

#### ASSUMPTIONS AND TENTATIVE HYPOTHESES

For the purpose of this study, the assumptions are:

- (1) The United States Air Force will maintain its forces in the Pacific and European theaters.
- (2) The planned number of new U.S. Air Force fighters will be integrated into the Air Force as scheduled.
- (3) Control of the air will continue to be a military objective to insure successful surface operations.
- (4) In any future war involving U.S. forces, rules of engagement will be imposed on the conduct of air warfare.

Tentative hypotheses are:

- (1) Aggressor squadron personnel/equipment provide the most realistic, cost effective method of dissimilar training today.
- (2) There will be a continuing need for Aggressor Squadron training in the future.

#### LIMITATIONS

The development of this study is bounded by certain limitations. The author intends for the study to be unclassified, thus restricting an in depth account of friendly and enemy tactical formations that remain classified. This information, though supportive in nature, is not crucial to the analysis of the subject. Dissimilar air combat training (DACT) is presently being conducted in the Pacific

theater, the United States, and the European theater. However, the emphasis of this study will concentrate on the European theater. The author considered the proclivity of all sources researched to produce an objective study.

#### IMPORTANCE OF THE STUDY

These unique Aggressor training squadrons that appeared on the Air Force flight training scene after the Vietnam conflict were born out of a need to re-evaluate U.S. Air Force training in combating enemy aircraft. The squadrons are made up of instructor pilots who teach Soviet air combat tactics in both classroom instruction and actual air combat scenarios. Ground Control Intercept (GCI) personnel are also an important part of this operation in producing the desired Soviet intercept tactics. This dissimilar air combat program was established at a time when U.S. Air Force F-4 pilots were training in air-to-air combat against each other in similar aircraft with less than optimum results. Now that the F-15 and F-16 are in production, is there still a need for Aggressor squadrons to perform this dissimilar air combat role? This study attempts to provide that answer.

#### METHODOLOGY

Chapter II puts into historical perspective the development of tactics and strategy of aerial combat, identifying problems that continue to exist today. The investigation includes peacetime preparation for war as well as wartime operations.

Chapters III and IV provide the origin, development, and current operations of the U.S. Air Force Aggressor Squadrons. The

contributions of the U.S. Navy to the U.S. Air Force DACT program and the driving factors in the choice of aircraft for the role are included.

The evaluation of the Aggressor squadron operations in Chapter V and VI encompasses both training and cost analyses. To prove the effectiveness of Aggressor DACT, the author compares the air combat results of the Air Force and Navy in Southeast Asia during two distinct periods of air warfare. The first period, without an Aggressor DACT program, is compared to the second period, fought after the initiation of a Navy Aggressor DACT program. The future need of Aggressor training is analyzed by determining the effect of Aggressor training on a possible future conflict. This is accomplished by projecting the results of the previous exercise to a hypothetical future conflict. The effect of Aggressor DACT on peacetime air combat pilot skill is investigated by measuring pilot proficiency at the beginning and completion of an established Aggressor DACT program. These proficiency levels are analyzed using DACT questionnaires.

The cost considerations investigated in Chapter VI are aimed at finding the most economical vehicle to provide Aggressor training. The operating costs of the F-4, F-15, and F-16 are compared to the F-5 to make this determination.

The final chapter includes any observations, conclusions, and recommendations concerning Aggressor training that result from this study.



## CHAPTER I

### ENDNOTES

<sup>1</sup>Douhet, G. The Command Of The Air. New York: Coward-McCann, Inc., 1942, p. 197.

<sup>2</sup>Holloway, B. K., General, USAF. "Air Superiority In Tactical Air Warfare," Air University Review, Vol XIX, March-April 1968, p. 4.

<sup>3</sup>Holloway, p. 15.

<sup>4</sup>Sims, E. H. Fighter Tactics and Strategy 1914-1970. New York: Harper and Row, 1972, p. 29.

<sup>5</sup>"New Look At a NATO Air War," Armed Forces Journal International, May 1974, p. 34.

<sup>6</sup>Terrance, E. P., Rush, C. H., Kohn, H. B., and Doughty, J. M. Factors in Fighter-Interceptor Pilot Combat Effectiveness, AFPTRC-TR-57-11, Air Force Personnel and Training Research Center, Lackland AFB, Texas, November 1957, p. 2.

<sup>7</sup>"New Look," p. 34.

## CHAPTER II

### EVOLUTION OF AIR-TO-AIR COMBAT

General Hap Arnold, commanding General of the U.S. Army Air Forces in World War II, once stated that the successful employment of aircraft revolves about four fundamentals: the strategic and tactical employment of the air elements involved, the excellence of the aircraft and its auxiliary equipment, the training of the individual and the training of the unit.<sup>1</sup> Though these fundamentals have been tested and proven true, we have not always applied these properly in our conduct of war operations.

During the 1920's and 30's, the belief was widely held that bomber attacks alone on enemy industry and population centers would force surrender early and reduce the historically large commitment of ground forces. The emphasis on bomber development and employment and the lack of emphasis on fighter aviation became evident in World War II with bomber raids into Germany from bases in England. The P-38s and P-47s of VIII Fighter Command could only escort the bombers to the European coast and fuel reserves were insufficient to allow offensive fighter sweeps to eliminate enemy fighters.

"The myth of bomber invulnerability was exploded over Schweinfurt, Regensburg, Kiel, and other targets in Germany before the end of that first year of combat, with losses on some missions running as high as 50 percent."<sup>2</sup>

Losses were so great that no further unescorted bomber penetrations were attempted until the Luftwaffe fighter threat had been reduced.

This realization of the importance of "pursuit" aviation to counter the enemy air threat brought revolutionary changes to aerial operations. Fighter combat radius was improved through the use of belly tanks, and our fighters were then able to conduct offensive fighter sweeps into Germany. Eventually the allies gained control of the air over Germany by the spring of 1944, but at a dear price in both equipment and personnel.

"In the European and Mediterranean Theaters alone, U.S. air forces lost 4,326 fighters and bombers prior to June 1944. Nearly 17,000 of our aircrew people were killed in action, and more than 21,000 were missing or prisoners of war."<sup>3</sup>

The United States was not the only nation that learned in World War II the value of air superiority and the exorbitant cost of not having it.

Both Germany and Russia misjudged the importance of air superiority. Germany built her World War II air force on the theory that her air force should be designed to work closely with the German Army for Continental conquest. Therefore, Germany did not have an air force designed to carry offensive air warfare across the English Channel and the North Sea. "German leaders rightly guessed that no invasion would be possible until air supremacy was established; it was never won and the invasion could not be launched."<sup>4</sup> The Germans fared much better on the Eastern front, where the Russians were to learn the value of air superiority. At the time Hitler launched his attack on the Soviet Union, his air force was approximately half the size of the Soviet fighter force. However, most of the Soviet fighters were designed for the ground attack role, so the superior Luftwaffe aircraft and pilots scored a phenomenal number of kills against inferior Soviet aircraft. This expensive lesson in air

superiority was not lost on Soviet airmen, because five years after V-E Day the Soviets were putting into the field jet fighters that were technically the equal of any air superiority fighter in the world. Before the close of 1950 U.S. pilots were to find out in Korea's famed MIG Alley just how good their fighters were.

The U.S. Air Force won air superiority quickly in Korea, but our entry into the Korean War revealed many training and equipment problems. When the Korean War began, deficiencies which adversely affected our ability to wage war in our new jet fighters were shortages of helmets and oxygen masks for pilots, and auxiliary ground power and fuel servicing units for the aircraft. Limited congressional funding forced the U.S. Air Force to cut the training programs, and rocket training was all but halted due to the economy program levied on the services. It appeared that even our aircraft didn't measure up to the task. The first all-jet encounter in the Korean War proved our F-80 was no match for the new MIG-15. The new F-86 Sabrejet was rushed to Korea to provide our pilots a more capable air combat aircraft. It was slower than the MIG-15 aircraft, but it was more rugged, highly maneuverable, and had comparable armament with a slightly superior gunsight. The MIG-15s enjoyed altitude and acceleration advantages, but Korean and Chinese pilots failed to exploit these advantages properly.

The MIG-15s vastly outnumbered the U.S. Air Force F-86s, and enemy sections were usually vectored by Ground Control Intercept (GCI) to attack positions above the F-86s. Often the MIG-15s would execute a single diving pass, but if they chose to turn in the engagement, the F-86 pilot quickly gained the advantage. F-86 pilots would "sucker"



the MIG into thinking the MIG was outturning the F-86, then the F-86 at the critical moment would reverse the turn and pop the speed brakes, forcing the MIG, which could not turn as readily, to overshoot to the side. The F-86 then would slide onto his (MIG) tail for a gun attack.<sup>5</sup> Sabrejet flight leaders separated their flights to confuse enemy radarscopes and this helped nullify the initial advantage which radar plotting and vectoring gave the enemy fighter on first sighting the enemy.

Chinese pilots became our primary air threat when the North Korean pilots relinquished air superiority to U.S. pilots after the first two months of the war. As an air force, the Chinese Communist Air Force was very young, and its pilots were not yet skilled enough to use their aircraft to its greatest advantage. For the most part, the MIG pilots hugged the Yalu and preferred to make their attacks from high and to the rear of American planes. Seldom did a MIG flight make more than two passes before breaking off combat at the border, thus using the sanctuary to deny our fighters a chance to engage them.

"Most MIG pilots, moreover, were inept gunners: they consistently fired while beyond effective range, failed to take proper lead, and, on at least one occasion, a MIG pilot lost an almost certain kill when he ceased fire while in effective striking distance."<sup>6</sup>

Since insufficiently trained Chinese pilots had been unable to take control of the air over Northwestern Korea, a new "International Communist Volunteer Air Force" would lend a hand. Some of the MIGs were flown by Soviet or Soviet-satellite pilots, for Sabre pilots occasionally saw blond Caucasians parachute from stricken MIGs.

There was a sudden change in tactics by the Communists in December 1951. The Sabre pilots noticed that the Reds followed a

definite cyclical pattern of air operations which indicated that combat training was their primary concern. At first the MIGs flew high and fast in large formations, and they were neither proficient nor aggressive. As they gained proficiency, the "class" flew at lower altitudes and engaged the F-86 Sabrejets, employing well planned tactics. Then a new "class" would appear on the scene, again flying high and in large formations. It became evident at this time that the Communists were no longer trying to attain air superiority. Rather, they were seeking to train a maximum number of pilots and to test their equipment and tactics against the United States Air Force. Sabre pilots encountered many variations of air-to-air tactics to include the Decoy, Uppercut, Staircase, Pincer and Envelopment, Yo-Yo, Zoom into the Sun, and Hit and Run. A detailed study of these formations and tactics may be found in James T. Stewart's book entitled Air Power: The Decisive Force in Korea, published in 1957. In most maneuvers against our F-86 Sabrejets the Communists relied heavily on the MIG's superior rate of climb and superior numbers - sometimes as much as 25 to 1.

Air-to-air combat picked up momentum in the summer of 1953. In the month of June 1953,

"the Sabres sighted 1,268 MIGs, engaged 501, destroyed 77, probably destroyed 11, and damaged 41....In this peak month of Sabre kills not a single friendly plane was lost in air-to-air combat. Most enemy pilots were pitifully incompetent."<sup>7</sup>

When the armistice brought the war to an end, the final outcome was 810 MIGs shot down to 56 Sabrejets shot down. "The incredible 14-to-1 beating handed the enemy was largely a product of USAF pilot skill and combination of quality leadership, integrated teamwork, and diligent

and ingenious use of air resources."<sup>8</sup> The pilot proved to be the greatest single factor in the achievement of this high kill-to-loss ratio in the air fighting. A Far Eastern Air Force (FEAF) statistical study made in March 1953 demonstrated that our victories were usually scored by the more experienced pilots.

"Pilots with MIG kills had flown an average of 18 missions in World War II, while pilots with no kills had flown an average of four missions in World War II. Out of a total of 810 enemy planes claimed destroyed by Sabres, moreover, the 38 Sabre pilots who became jet air aces destroyed 305.5 planes."<sup>9</sup>

Though General Hap Arnold had always stressed quality training, the statistical study reinforced his view that a pilot's peak performance could be obtained only by an accumulation of experience.<sup>10</sup> In the final analysis, the Korean War demonstrated that a small, thoroughly trained air force can overcome one superior in size and equipment, but deficient in training or experience. Our maintenance of air superiority was aided a great deal by the enemy's misuse of aircraft capabilities and lack of skilled pilots.

After 1953, air superiority, so far as the fighter aircraft were concerned, was limited to the defense of the United States against enemy bombers. Our tactical fighters such as the F-105 and F-104 were designed for nuclear strike or high speed intercept rather than maneuverability. The U.S. Air Force entered the Southeast Asia conflict without an aircraft designed primarily for air combat. Once again we conformed to the pattern that has prevailed throughout history by permitting our military potential to reach a state of limited effectiveness.

As we entered the war in Vietnam, however, it became obvious that our nuclear might would be of limited value in a conflict of this nature. Our conventional air warfare expertise was outmoded and conventional weapons development had virtually ceased. "The air-to-air gun was considered anachronistic, and aircrew training was fragmented."<sup>11</sup> The training requirements of aircrews also increased greatly as the multirole F-4 Phantom fighter-bomber became the "work-horse" of the war. The author, as a typical F-4 pilot assigned to a squadron in Southeast Asia, flew bomber and reconnaissance escort, air-to-air patrol, interdiction, close air support, night gunship escort, all-weather navigation bombing, and LORAN bombing missions.

As the enemy radar systems improved, it became necessary to take F-4s out of the strike role and use them for air-to-air combat. Better integration of radars and an increased number of MIG-21s allowed the North Vietnamese to experiment with new tactics. "Since the North Vietnamese had only a small fighter force, it was necessary that it be under very close control and that it be committed to battle only when the situation was most favorable."<sup>12</sup> The first part of the war saw many dogfights with close-in gun attacks, and our pilots found the MIG-17 and 21 held an extreme advantage in a turning engagement. Even though we finally brought into the conflict an F-4 fighter with an internal 20mm gun and improved turning capability, we found that high speed slashing attacks with little or no turning consistently gave us the most favorable results. During the 1972 campaign, 50 percent of the F-4 gun attacks were successful.<sup>13</sup> But the North Vietnamese capitalized on their superb radar control to employ



the MIG-21s in supersonic stern attacks with missiles instead of the gun. A high speed stern attack allowed the MIG-21 to attain infrared missile parameters for greater possibility of a kill, use the element of surprise, and depart the area without becoming decisively engaged.

The four-ship tactical formations used by the U.S. Air Force provided excellent visual lookout capability but were too cumbersome to maneuver as a fighting unit in an air-to-air battle. Two of the four aircraft, usually flown by the more inexperienced pilots, were often limited to flying an inflexible "welded" wing position, contributing very little to an offensive engagement. The 1779 hours flying average for U.S. Air Force pilots with MIG kills as of December 1967 should be viewed in light of this restriction placed on the inexperienced pilots.<sup>14</sup> The high turnover rate of pilots due to the short tour length of duty in Southeast Asia produced a steady flow of new, inexperienced pilots into the theater, helping to solidify the four-ship "mutual protection" air-to-air flight for the remainder of the war. Understandably, not all pilots committed to battle will have had previous combat experience. Training, then, becomes an important element in air superiority.

How effective was our peacetime training preparation for aerial combat? Prior to World War II General Giulio Douhet stated that the war in the air would be decided by those aerial forces in being and prepared when hostilities broke out. The United States entered World War II unprepared, but the length of the war allowed us to produce quality training programs. Again the United States entered the Korean War with little training preparation, but fortunately, experienced World War II pilots were available and carried the brunt of the air

effort in Korea. The lessons of Korea were soon forgotten, as General Holloway, Commander, U.S. Air Force, summarized the training of our air-to-air pilots after Korea in an Air University Review article.

Between 1954 and 1962 the USAF training curriculum for fighter pilots included little, if any, air-to-air combat. This omission was partly a result of doctrine, which then regarded tactical fighters primarily as a means for delivering nuclear ordnance. It was partly a reflection of concern for flying safety. In any event, as late as October 1963 it was reported that only four of 30 pilots in one fighter squadron had ever shot aerial gunnery.<sup>15</sup>

Since the years between Korea and Vietnam reduced U.S. Air Force combat experience to an ineffectual level, the air-to-air training program of Tactical Air Command would now determine the outcome of the air-to-air engagements in Vietnam. The quality of air combat training did not increase appreciably beyond that described by General Holloway. In fact, little command guidance was given on air-to-air combat training until we were in the middle of the air battle.

This reluctance to prepare for the air-to-air mission could be attributed to many factors: Counterair (strike enemy airfields and aircraft on the ground) operations; development of long-range radar missiles that could kill with little flying skill required; flying safety considerations of air combat training; and air defense intercept training with no emphasis on fighter-versus-fighter dogfighting. The fallacy of these factors became evident in the localized air war over North Vietnam, which was constrained by political objectives and rules of engagement (ROE) requiring visual identification of enemy aircraft prior to weapon release. Finally, our use of the F-4 in numerous roles in Southeast Asia constrained the type and degree of training provided to pilots upgrading in the F-4s.

All F-4 Replacement Training Units (RTUs) provided the same general instruction which emphasized the air-to-ground mission. Student pilots rarely benefited from good gun-camera film programs or had an opportunity to fly air combat against other aircraft with different capabilities. The average student pilot was not adequately trained to engage in a dogfight with the enemy, and even the tactics and maneuvers being taught were largely ineffective against a highly maneuverable enemy.<sup>16</sup> The disappointing 2.12 kill ratio of the U.S. Air Force fighters over North Vietnamese fighters demanded a training correction. The U.S. Air Force initiated a "TOPOFF" program in 1972 at Nellis Air Force Base, Nevada, to train selected F-4 aircrews in advanced air-to-air scenarios. This training, along with an aircraft airfoil modification to increase the F-4 dogfight capability, arrived on the scene just in time for the final curtain call of the war. For an encore, the U.S. Air Force created a special squadron to provide dissimilar air combat training and enemy tactics to tactical fighter pilots. The birth of this unique "Aggressor Squadron" was to herald a new era in air combat training.

## CHAPTER II

### ENDNOTES

<sup>1</sup>Arnold, H. H. Lieutenant General and Eaker, I. C., Brigadier General, U.S. Army. Army Flyer. New York: Harper and Brothers, 1942, p. 231.

<sup>2</sup>Holloway, B. K., General, USAF. "Air Superiority In Tactical Air Warfare," Air University Review, Vol XIX, March-April 1968, p. 8.

<sup>3</sup>Holloway, p. 4.

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### CHAPTER III

#### ORIGIN OF USAF AGGRESSOR SQUADRON

As a result of the disappointing kill ratio of the U.S. Air Force fighter pilots over North Vietnamese pilots, Tactical Air Command instituted more realistic training programs to better prepare our fighter pilots for aerial combat. Most noteworthy was the establishment of dissimilar air combat training conducted by a professional adversary force - the "Aggressors." Tactical Air Command's Dissimilar Air Combat Training (DACT) program came to fruition in July 1973 with the squadron's deployment to Homestead Air Force Base, Florida.<sup>1</sup>

The 64th Fighter Weapons Squadron was equipped with unmodified Air Training Command T-38s which approximated the size and performance of enemy aircraft and manned by selected, highly qualified fighter pilots who were schooled in both American and Soviet air combat tactics. These pilots were controlled by radar weapons controllers trained in tactical air combat. This team of Ground Control Intercept (GCI) controllers and pilots taught TAC's fighter pilots how to engage, kill, or separate from an adversary flying a different airplane. The 64th Fighter Weapons Squadron (FWS) was chartered to provide basic DACT to TAC aircrews and a realistic adversary for exercises and evaluations through flight instruction and nine hours of academic presentations.<sup>2</sup> The immediate acceptance and success of Aggressor training led to the eventual activation of another squadron at Nellis Air Force Base, Nevada, and two squadrons overseas - one in

the Pacific and one in Europe. Dissimilar training had "come of age" in the U.S. Air Force as described in official flying regulations.

The fundamental objective of the dissimilar aircraft ACT (Air Combat Training) program is to prepare aircrews to enter the aerial combat arena and attain the highest possible success. It is essential that aircrews be trained to employ current tactics while operating their aircraft within its optimum combat envelope. This is best achieved by exposing aircrews to various simulated threat aircraft employing current enemy tactics.<sup>3</sup>

Even though the U.S. Air Force DACT program was conceived late in the Southeast Asia conflict, much credit for its existence must go to the U.S. Navy, which also recognized a need for dissimilar training and reacted more quickly, thus paving the way for the U.S. Air Force program.

The Navy's record of 2.42 kills for every loss was unimpressive during the 1965-68 period, and in mid-1968 Lieutenant Frank W. Ault, a Naval aviator, was nominated to produce a general report on the weaknesses of U.S. Naval aviation in air superiority engagements, based on those which took place between July and November 1968. "The first conclusion was that pilot training needed to be fundamentally revised."<sup>4</sup> The Navy responded by setting up the Fighter Weapons School at Miramar Naval Air Station. The first graduates from the new school, baptised "Top Guns", joined operational units in April 1969 and thereafter at the rate of four aircrews per five-week course, five courses per year. By 1972 many pilots had received this training, and conclusive proof of the effectiveness of this program came in 1972 with the renewed U.S. air operations over North Vietnam. "The U.S. Navy's kill ratio improved from 2.42:1 in the 1965-68 period to 12.5:1 for 1970-73, with most of the engagements taking place in 1972."<sup>5</sup>

The majority of the Navy's MIG kills during this period were credited to "Top Gun" graduates that included the first "ace" of the war, Lieutenant Randy Cunningham. Also in 1972, the last full year of the war, Navy pilots scored 1.04 kills per engagement - roughly five times better than the average for all fighter forces during the war.<sup>6</sup> For the Navy, the problem seemed to be a simple one of transforming Fleet defense interceptor pilots into close range combat fighter pilots. The U.S. Air Force, on the other hand, was not so fortunate.

While Navy F-4s were tasked primarily with air-to-air missions, the U.S. Air Force F-4s and crews had a greater number of different roles to fulfill, such as close air support, interdiction and air superiority missions. Tactical Air Command's 1970-73 kill ratio of 2.0:1 could well be attributed to the fact that most Tactical Air Command pilots had little specialized air-to-air training apart from the basic F-4 versus F-4 air combat training received in primary F-4 flight instruction. A few pilots of the U.S. Air Force Fighter Weapons School had flown dissimilar air combat training missions. Captain Steve Ritchie, Tactical Air Command's first and only pilot to become a Vietnam ace, was one of these.

Air Defense Command (ADC) emphasized realistic air-to-air training and sent its air combat training instructor pilots to the Fighter Weapons School to sharpen their skills in the dogfight arena. Air Defense Command went one step further in June 1970 by establishing a dissimilar combat program with Naval and Marine fighter squadrons.<sup>7</sup> This positive step allowed Air Defense Command F-106 pilots to be exposed to the tactics of pilots from different squadrons. Both Navy and Air Defense Command pilots modified and

refined their tactics as a result of this interservice training. The F-106 pilots flew more than 6,000 missions with Navy and Marine Corps F-4 Phantoms and A-4 Skyhawks during the period 1970-73.<sup>8</sup> Tactical Air Command pilots, on the other hand, graduated from F-4 training during this period and entered the Vietnam conflict without the benefit of dissimilar air combat training. The poor Air Force results in air-to-air combat in Vietnam, the Navy's improved results in 1972, and Air Defense Command's accident-free dissimilar training program spurred Tactical Air Command to set up its own special combat training organization, the 64th Fighter Weapons Squadron.

Rationale for establishing the 64th Fighter Weapons Squadron was provided by Lieutenant Colonel Jerry H. Nabors, 64th Commander, in March 1975 to the Tactical Air Power Subcommittee of the Senate Armed Services Committee.

During the Southeast Asia conflict, an extensive study was accomplished to reconstruct each MIG encounter that occurred in the war. The objective was to determine the reasons for success or failure in the encounter and to identify problem areas that could be resolved to provide the United States with a better fighting force.

The most common problem found could be summed up in the words 'insufficient training and experience in air-to-air combat.' The air-to-air training that had been conducted was conducted against similar aircraft using USAF tactics. Yet most of the maneuvers and tactics employed in attacking or defending in aerial engagements depend upon performance characteristics of your aircraft versus your adversary's aircraft, correct estimation of his range, and knowledge of his tactics. It was determined that similar aircraft training - for example F-4 versus F-4 - was unsatisfactory when engaging better turning MIG aircraft. Visual lookout procedures and training were adequate to acquire an aircraft of similar size to yours, but grossly inadequate to detect the smaller MIG's. As a result, many kills were obtained by the enemy totally undetected until it was too late to react.



Even when detected, crucial errors were made in visual range estimations which resulted in certain necessary aerial maneuvers being employed at the wrong point in space or not at all. Also, enemy tactics had never been flown in training scenarios. An urgent need existed for an air-to-air training program using aircraft with comparable characteristics of the potential enemy aircraft and flown by pilots who had extensively studied the enemy fighter pilot and were skilled in his tactics and fighting philosophy.<sup>9</sup>

The 64th Fighter Weapons Squadron became operational in June 1973 with twenty instructor pilots, twenty T-38 aircraft, and one Ground Controlled Intercept (GCI) site manned by six radar control officers. The pilots were specially selected experts in air combat - most were previous MIG killers or graduates of the Fighter Weapons School and Air Defense Command Interceptor Weapons School. The GCI controllers were included in this new training concept because Soviet tactical philosophy and doctrine called for radar control of fighters on all missions. These Aggressor Squadron controllers were thoroughly schooled in Soviet intercept tactics, and they controlled Aggressor pilots using these tactics.

From the beginning, the Northrop F-5E Tiger II lightweight fighter was recognized as the aircraft which most closely met the principal Soviet air-to-air fighter's size and performance characteristics, but the F-5E was not available for this program. The South Vietnamese requirements for the F-5E superceded other requirments at the time. The next choice was the T-38 Talon, a two seat supersonic trainer also manufactured by Northrop Aircraft Corporation. The Navy had used some older T-38 airframes successfully in its "Top Gun" program several years earlier. So the Air Force selected the T-38 for its dissimilar air combat program. The Chart (Figure 1) shows that

the T-38 can not duplicate the MIG-21's turning performance as well as the F-5E.<sup>10</sup>

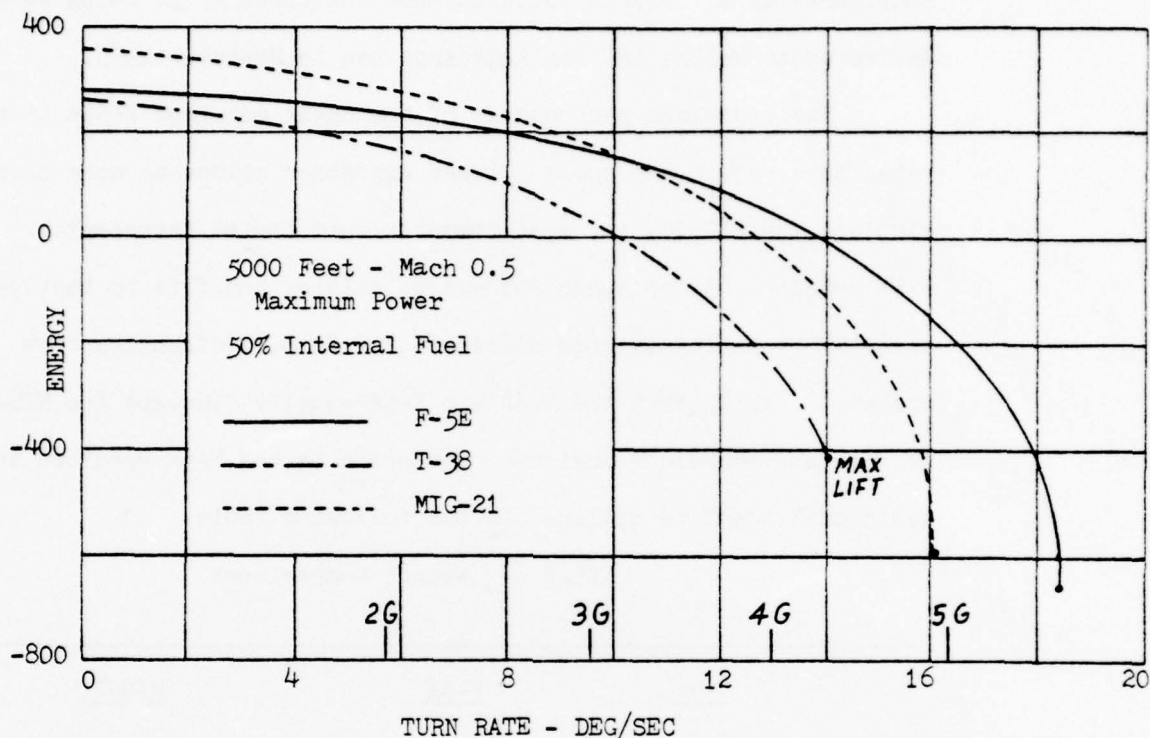


FIGURE 1. Turn Rate Comparisons of T-39, F-5E, and MIG-21

Like the MIG, the T-38 is small, extremely hard to see, and has smokeless engines. Neither has the tell-tale smoke trail which makes the F-4 so easy to see. Enemy tactics flown by Aggressor Squadron pilots in T-38s gave fighter pilots an unprecedented opportunity to experience the realism of fighting against a MIG type aircraft in a controlled environment. While the T-38 was a good MIG simulator, it was not designed for the sustained G-forces necessary in air combat and it could not exceed Mach 1.1.<sup>11</sup> This speed limitation gave F-4 pilots an erroneous impression that they could easily extend out of

the lethal range of Soviet air-to-air weapons, since the F-4 could out-accelerate the T-38 rather quickly. The T-38 Talon trainer was considered as an interim solution, and the first of 18 F-5Es were delivered to Nellis AFB for Aggressor use in November 1975.

The increased performance of the newly acquired F-5Es in turn rate, turn radius and speed allowed Aggressor pilots to more closely simulate the MIG-21, the most commonly used Soviet interceptor. The F-5E's Mach 1.63 top speed increased training benefits to tactical aircrews by making it more difficult for them to disengage from combat.<sup>12</sup> While both the T-38 and F-5E equally simulate the MIG-21 in size and smokeless engines, conversion to the F-5E resulted in additional benefits outlined in the following table.

TABLE 1. Weapon Comparisons

	<u>T-38</u>	<u>F-5E</u>	<u>MIG-21</u>
Radar	None	Range only	Range only
Gun	None	20mm cannon	30 mm cannon
Missiles	None	23 Infrared	2/4 Infrared

The F-5E's computing gun sight with ranging radar makes accurate attainment of weapons launch possible. Carriage of infrared heat seeking missile trainers for validation of simulated Soviet missile launches and a gun camera for validation of simulated gun and missile kills enhances realism not possible with the T-38. The introduction of the F-5E, then, has allowed the Aggressor Squadrons to have a profound impact on U.S. Air Force tactical fighter operational readiness.

### CHAPTER III

#### ENDNOTES

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## CHAPTER IV

### ROLE OF THE AGGRESSOR SQUADRON

There has been great debate over what aerial combat might be like in the future. Major General Frederick C. Blesse, an Air Force pilot who became a double ace in Korea and flew 108 combat missions over North Vietnam, says that 95 percent of our future air-to-air fighting will be done at long range.<sup>1</sup> He foresees an Air Force and Navy full of aces who have never seen the enemy. Some students of Soviet military doctrine believe that the Soviets will mount an initial attack made up of several waves of bomber and attack aircraft escorted by fighters deep into NATO territory to knock out conventional forces and nuclear reserves. Therefore, the air battle will be more and more a matter of electronic acuity and avoidance, less and less a matter of pilot skill and ferocity."<sup>2</sup> The highly sophisticated fire control systems and radar missiles of the F-14 Tomcat and F-15 Eagle aircraft seem to substantiate General Blesse's view. But our F-14 and F-15 resources are limited due to high costs, and even these sophisticated aircraft would be overwhelmed by the sheer magnitude of the threat force. A primary assumption of the Department of Defense is that the war is expected to continue beyond the initial attack.<sup>3</sup> The author agrees with Charles E. Myers, Jr., former head of tactical air warfare research for the Pentagon, who suggested that major crowded dogfights would constitute the primary

air-to-air combat activity in a future Warsaw Pact - NATO engagement.<sup>4</sup> It will be a much more intense air war than American airmen fought in Southeast Asia. The use of long range radar guided air-to-air missiles may be of limited use because of the crowded and chaotic conditions. "DOD planners are talking about 6,000 to 8,000 tracks in one day through a band only 100 miles wide compared with only 40 to 50 enemy and 80 to 100 friendly tracks at any one time over North Vietnam."<sup>5</sup> With degraded command and control, it will be very difficult to sort out friend from foe. In such a situation, fighter pilots will be forced to defeat the enemy with superior air combat maneuvering and accurately delivered air-to-air ordinance. The author is not attempting to show disdain for the superb capabilities of our newest radars and all-aspect missiles, for these can be exploited in a controlled environment. However, the complexity of the air battles, political constraints, and simple confusion in an area of unpredictable dynamics make all of our technology only an aid, not a complete answer. In the words of a Marine fighter pilot writing on our current fighter posture, it is "still an airborne bayonet fight."<sup>6</sup> Rules of engagement will determine how we employ our airborne weapon systems in Europe just as they have in every air war in the past. Visual identification is but one of the rules of engagement which have hindered the full use of our weapon systems. But we cannot ignore rules such as visual identification requirements; violations have resulted in F-4's being shot down by other F-4's during the Vietnam War.<sup>7</sup>

If there is a high probability that visual identification and close air combat will be required in our next conflict, then our

fighter aircraft should be designed with these capabilities. Fortunately, whether or not they get into a dogfight, the F-14, F-15, F-16, and F-18 are highly maneuverable fighters and meet these requirements. Although the major role of the tactical air forces in Europe is support of the ground forces, significant air combat is anticipated.

The Air Force has long argued that, although the specific scenario will dictate how its forces are used, air superiority must be achieved before extensive air-to-ground attack in support of the Army ground forces can be undertaken. The reason underlying this argument is twofold: first, that in the early stages of a war the Air Force believes it must suppress the air threat so that it can operate relatively unhindered, keeping attrition to acceptable proportions; and second, that achieving air superiority is of primary importance to the Army anyway, since it secures them from enemy air attack.<sup>6</sup>

Knowledgable tacticians agree that one of the most effective counters to enemy air power is to destroy it on the ground. This element of our doctrine is being re-examined today. Interdiction of Warsaw Pact airfields may prove too costly in light of the recent aircraft shelter program, dispersal techniques, and heavy air defense system. A major part of the air superiority battle, then, will likely take the form of air-to-air clashes of fighter aircraft. If this new strategy for a NATO air war is to be effective, the United States will have to force a better exchange rate than we achieved over North Vietnam. How do we insure that our fighter pilots will be able to successfully counter the Warsaw Pact air threat? We can do this most effectively by providing them with the most realistic enemy threat training possible.

The Aggressors provide this service by flying an aircraft similar in size and performance to the MIG's, by employing the enemy's

formations and tactics, and by using his fighting philosophy. The original charter of the first Aggressor squadron remains unchanged, but the mission has expanded to include the following elements: Aggressor pilot and controller upgrade training, operational fighter unit training, Replacement Training Unit (RTU) training, Fighter Weapons Schools, exercises, and Test and Evaluation (T&E). Four Aggressor squadrons handle these worldwide requirements. Two squadrons at Nellis AFB, Nevada, upgrade all Aggressor pilots and controllers and provide Aggressor dissimilar training for the fighter units in the United States. Additional important functions are to act as the enemy air threat for Red Flag exercises and for evaluation of our newest weapon systems such as the F-14, F-15, F-16, and E-3A. One squadron in the Pacific and one squadron in Europe conduct training and exercises for operational fighter units in its theater. The 527th Aggressor Squadron (Europe) has also conducted dissimilar training with NATO aircrews from the United Kingdom, Denmark, and Greece. In fulfilling the Aggressor mission in 1977, the four squadrons flew over 17,000 sorties and trained over 1,300 aircrews.<sup>9</sup> The worldwide Aggressor assets are:

TABLE 2. Squadron Authorizations<sup>10</sup>

<u>COMMAND</u>	<u>AIRCRAFT</u>	<u>PILOTS</u>	<u>CONTROLLERS</u>
TAC (64/65th Squadron)	44 F-5E	54	14
USAFE (527th Squadron)	18 F-5E	22	9
PACAF (26th Squadron)	8 F-5E	15	6
	4 T-38		

The author will use the 527th Aggressor Squadron at RAF Alconbury, England to describe the training. The 527th Aggressor



Squadron flew 5,221 sorties in 1977 in support of both United States and Allied forces.<sup>11</sup> The 527th completed 29 deployments to various bases in Europe.

#### TYPICAL AGGRESSOR DEPLOYMENT

##### 527th Squadron Resources

- o 6 - F-5E Aircraft
- o 6 - Aggressor pilots
- o 2 - Weapons controllers
- o 12 - Maintenance Support personnel

##### Training Provided

- o 12 - F-5E sorties per day
- o 12 to 24 host unit sorties per day

This is a typical deployment package that usually terminates in one or two weeks. The number of daily host unit sorties depends upon the mission scenarios flown. The sequence of events for a typical deployment are:

- o Host Unit Request
  - o Coordination
    - o Phase Briefing
    - o Academics
    - o Flight Briefings
    - o Deployment Evaluation

A request for dissimilar training is initiated by a tactical fighter or reconnaissance wing to Alconbury. The schedule is approved by Headquarters, USAFE, and coordinated for logistics support, operating areas, and radar facilities. Upon arrival of the Aggressors at the host base, a briefing is conducted concerning the objectives of the program, rules of engagement, local operating procedures, and

safety directives. Aggressor squadron instructors then provide eight hours of academics to the aircrews concerning Soviet aircraft, armament, formations and tactics, and air defense system.

The academic program has proven to be an extremely valuable one in providing the aircrews with maximum knowledge of the enemy. Aggressor pilots continually update the academic subjects through extensive research of enemy manuals, Soviet defector interviews, and review of worldwide air-to-air encounters. The research associated with the program has established the Aggressor squadrons as a central collection and analysis agency on the current Soviet air-to-air threat.

Mission outlines are provided for offensive, counter offensive and defensive sorties which are tailored to the role, mission, and experience level of the unit's aircrews.

#### MISSION OUTLINES

##### BASIC MISSIONS

- Offensive
- Counter Offensive
- Defensive

##### INTERMEDIATE MISSIONS

- Sequential Attacks
- Split Plane Maneuvering
- Defensive Maneuvering

##### ADVANCED MISSIONS

- Variable Sequence
- Multiple CAP
- Multiple Patrol
- Strike Force Integration

Before each flight, Aggressor instructors brief the specific mission

scenario and rules of engagement for the aircrews involved. After each flight the mission is extensively debriefed using tape recorders, radar scope, and gun camera film to accurately reconstruct engagements. Aggressor radar controllers attend the briefings to provide another professional evaluation of the tactics and maneuvers executed in the mission. This is especially important for the more complex missions that involve multiple aircraft attacks. Since our tactical aircrews must be prepared to fight a numerically superior force, we really have no choice but to train like we plan to fight.

The significance of training against a realistic threat aircraft has been acknowledged by both Air Force and Navy pilots. The Navy's A-4, with good turning performance but low thrust-to-weight and subsonic capability, was a good MIG-17 simulator. However, pilots who trained against this simulator developed habits that were not acceptable when fighting a MIG-21. It becomes easy for the pilots of F-4s, F-14s, and F-15s to mismanage their aircraft and underestimate the real enemy threat if our threat simulators do not represent that threat accurately. The introduction of the Aggressor concept of training and the "MIG like" F-5E have given our pilots an opportunity to experience the most realistic air combat training available today. This is the role of the Aggressor squadron.

## CHAPTER IV

### ENDNOTES

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<sup>3</sup>U.S. Congress. Budget Office. "Planning U.S. General Purpose Forces: The Tactical Air Forces," Budget Issue Paper, Washington, D. C., January 1977, p. 7.

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<sup>9</sup>U.S. Congress. Senate. Committee on Armed Services. Department of Defense Authorization For Appropriations For Fiscal Year 1979, 5 April 1978, p. 5231.

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## CHAPTER V

### EVALUATION OF AGGRESSOR TRAINING

Traditionally, evaluation of air-to-air combat has been limited to the comparison of the performance characteristics of the aircraft. Any discussion or document pertaining to dissimilar air combat training (DACT) will likely include comparisons of the physical attributes and performance parameters of the aircraft involved. This is normal because "hard data" exists and these comparisons are easily quantified. An equally important but seldom documented factor is that of aircrew training. Research of this area has revealed sources dating from the World War I era to the Yon Kipper War which conclude that individual aircrew capabilities significantly affect the outcome of air-to-air combat. In fact, aircrew training and experience is credited with being the most significant and consistent factor in determining the outcome of air battles.<sup>1</sup>

Analytical examinations of aircrew training and its influence on air-to-air combat are almost non-existent due to the complexity and dynamics of aerial combat and the lack of training data. Most of the literature expounding the merits of aircrew training draws conclusions from historical accounts of our best air-to-air pilots of previous wars. The limited analysis that has been performed generally equates pilot skill with flying experience. Though there is a definite relationship, pilot skill is not dependent solely upon experience.

Pilot skill can be acquired through proper training. A Rand research project prepared for the U.S. Air Force in January 1977 investigated the influence of pilot training on combat skills, attempting to link aircrew training with air-to-air combat performance of U.S. pilots in Vietnam. However, Combat Crew Training Squadron (CCTS) documentation was not preserved, which made it impossible to derive and test what aspects of a pilot's training were the best indicators of his performance in combat.<sup>2</sup> This is unfortunate, for we need a better understanding between peacetime training and wartime results. The author can provide a correlation of this with respect to air-to-air combat.

One goal of this research was to evaluate the Air Force Aggressor DACT program by comparing the proficiency of pilots in air-to-air combat with Aggressor training to those with no Aggressor training. Since the Air Force currently has no meaningful way to objectively evaluate peacetime proficiency of its air-to-air pilots, how can the importance of the Aggressor DACT be measured? What effect would this proficiency, if measured in peacetime training, have on wartime air-to-air combat? The author investigated the importance of proficiency in Aggressor DACT by comparing wartime results of pilots with Aggressor training to wartime results of pilots without Aggressor training. This was accomplished by comparing U.S. Air Force and U.S. Navy air-to-air combat in Southeast Asia before and after the inception of the U.S. Navy's Aggressor DACT program.

The air war in Southeast Asia can be divided into two distinct four-year periods for analysis, 1965-1968 and 1970-1973. No planes were shot down by either side in air-to-air combat in 1969. The

following table shows our air-to-air results prior to the Navy's Aggressor program.

TABLE 3. Southeast Asia Air Combat Results, 1965-1968

SOUTHEAST ASIA AIR-TO-AIR COMBAT 3						
Year	USAF			NAVY		
	MIGs killed/losses		Ratio	MIGs killed/losses		Ratio
1965	2	3	0.67	3	1	3.00
1966	16	5	3.20	6	4	1.50
1967	55	21	2.62	14	4	3.50
1968	8	7	1.14	6	3	2.00
USAF average kill ratio 2.25			NAVY average kill ratio 2.42			

The kill ratios of the Air Force and Navy were similar for this period. The Air Force combat missions were built around four-ship tactics, while the Navy's combat missions were basically two-ship. The Air Force had no dissimilar air combat program with the exception of very limited dissimilar training provided only to Fighter Weapons Instructor course pilots. The Navy, on the other hand, flew dissimilar air combat in an intraservice program that involved F-4s, A-4s, F-8s, and A-7s. But this did not yield any visible benefit. The top leadership of the Navy, dissatisfied with Vietnam air-to-air results, requested that every facet of fighter aviation be examined - weapon system procurement, training, logistics, and operations.<sup>4</sup> Aircrew training was singled out, and a new "Aggressor" Fighter Weapons School was formed at NAS Miramar. The immediate objective was to place at least one graduate in every operational squadron to act as that unit's expert in enemy weapons and tactics. This orientation became a key factor in the 1970-1973 air war.

TABLE 4. Southeast Asia Air Combat Results, 1970-1973

SOUTHEAST ASIA AIR-TO-AIR COMBAT					
YEAR	USAF			NAVY	
	MIGs Killed/Losses		Ratio	MIGs killed/Losses	
1970	0	0		1	0
1971	0	1	0		
1972	45*	23	1.96	23	2
1973	1	0		1	0
					11.50

\*Does not include 2 MIGs shot down by B-52 tailgunners.

USAF Average kill ratio 1.92

Navy average kill ratio 12.50

The Air Force continued flying four-ship missions and the Navy maintained its two-ship missions. The only significant variable is the presence of a Navy Aggressor program. As for the variables on the enemy side, the enemy acquired a more sophisticated air defense network and increased the experience level of its pilots. Despite this, the Navy's air-to-air record over North Vietnam improved by a factor of five. The Air Force, on the other hand, showed no improvement in air combat capability for the second period. Transposing the Navy's improvement factor to the Air Force's second period of warfare results in the following table.

TABLE 5. Proposed U.S. Air Force Air Combat Results with DACT

SOUTHEAST ASIA AIR-TO-AIR COMBAT					
U.S. AIR FORCE					
Actual Data (w/o DACT)			Proposed Data (w/DACT)		
Period	MIGs killed/Losses		MIGs Killed/Losses		
1970-73	46	24	46	4	

Keeping the enemy kills constant reduces USAF losses by 20 aircraft.



This factorial increase in air combat capability becomes even more significant when allocated against up to 2,800 Warsaw Pact air-to-air fighters.<sup>6</sup> The air-to-air skills gained from Aggressor type training would not only reduce the number of one's own aircraft being lost in combat, but it would result in greater numbers of enemy aircraft being shot down. The expected impact of Aggressor training on a future NATO conflict can be examined more closely by an application of Southeast Asia air combat data. Calculations are based upon the following information:

1. U.S. Air Force air-to-air record of 127 MIG kills to 60 losses (1965-1973) is a 2.12:1 exchange ratio.
2. U.S. Navy air-to-air record after Aggressor training is 12.5:1 exchange ratio.
3. Pilot training cost of \$250,000.
4. Average aircraft replacement cost for a future NATO conflict of 10 million (estimated).

Assumption: if the exchange ratio of the Air Force were improved from 2.12:1 to 12.5:1, Air Force losses in a future conflict decrease by a constant (K) while Warsaw Pact losses increase by the same constant.

Algebraically:

Enemy losses in Vietnam	$V_e$	=	127
Friendly losses in Vietnam	$V_f$	=	60
Projected exchange ratio	$P_x$	=	12.5
Projected enemy loss	$P_e$	=	$K (V_e)$
Projected friendly loss	$P_f$	=	$\frac{V_f}{K}$

$$\begin{aligned}
P_x &= 12.5 = \frac{P_e}{P_f} = \frac{K^2(V_e)}{V_f} \\
12.5 &= \frac{K^2(127)}{60} \\
K^2 &= 5.9055 \\
K &= 2.43 \\
\text{Therefore: } P_e &= K(V_e) = 2.43(127) \\
P_e &= 308.6 \text{ enemy aircraft shot down} \\
P_f &= \frac{V_f}{K} = \frac{60}{2.43} \\
P_f &= 24.69 \text{ friendly aircraft shot down}
\end{aligned}$$

Using the cost factors noted above:

TABLE 6. Projected Air Force Losses in a Future NATO War

	Actual USAF Losses Vietnam ratio 2.12:1	Projected USAF Losses NATO ratio 12.5:1
Aircraft Lost	60	25
Pilots lost	60	25
Aircraft replacement Cost	600 Million	250 Million
Pilot training cost	25 Million	6,250,000
Total cost	625 Million	256,250,000
Cost factors for Vietnam consider only the pilot and use the aircraft replacement cost estimated for NATO conflict.		

The projected savings of \$368,750,000 represents an economic reduction of 59.0 percent. These computations are only meant to suggest savings that would be critical in a NATO war where the United States, with limited resources, will face a numerically superior Warsaw Pact threat.

The implications of this mathematical exercise, based on the improved air combat skills accredited to the Navy's Aggressor program,

help solidify the position that Aggressor DACT is germane to our success in a NATO conflict. The author concludes, then, that pilot skill in dissimilar air combat is an important determinant of the outcome of aerial combat, but how do we identify and measure the factors that make up those skills?

The traditionally accepted index for measuring air-to-air combat proficiency skills is the number of successes or kills made by a pilot. The end result - success or no success - can be quantified even in peacetime training through the use of gun camera or radar scope film. But this result alone is inadequate to provide a true measure of proficiency. There are other factors that need to be measured in training exercises to give us a more complete picture of our readiness posture. A well executed defensive maneuver by a pilot may not be converted into a kill of the enemy, but it would still indicate a high degree of pilot skill. "Red Baron III data indicate that close to one-third of the losses of U.S. aircraft over Vietnam could be attributed to inadequate pilot training."<sup>7</sup>

Any study of pilot proficiency, then, would have to consider defensive as well as offensive skill factors. Herbert K. Weiss, a systems analyst, attempted in 1966 to evaluate pilot skills using a systems approach (see Appendix B). Since a small number of pilots were historically responsible for most of the enemy kills, the outcome of aerial combat depended more on pilot performance than on numbers of pilots. Although Weiss' conclusions are not disputed by any other study known to the author, his analysis has some faults. He interchanges general flying experience with skill and uses some data from World War I that may not be as useful in today's air combat environment. Although

the correlation between flying experience and pilot skill is positive, a pilot with a lot of general flying experience may possess very limited air-to-air skills. A pilot must be subjected to that difficult environment through combat experience or training to develop that specialized skill. The outcome is surely the "proof of the pudding," but in today's Air Force of limited resources, we need a method of determining when we have arrived at the level of training required to defeat the enemy in air-to-air combat.

One basic problem is that, with respect to air combat, it is difficult to define what constitutes a trained pilot. Thus, if we can't describe all of the essential behavior, we cannot quantify that behavior. The Air Force's air combat record has resulted from training based more on tradition than on anything else. Criteria for establishing standards for specific tasks in air-to-air combat exist only in the most basic operational tasks. Any of the basic maneuvers executed against another aircraft may be evaluated or measured in a consistent manner against a cooperative aircraft. But a perfectly executed maneuver may be of no value if a non-cooperative aircraft elects to disrupt your attack by initiating a counter-maneuver. The complexity or fluidity of the air combat arena does not readily lend itself to a systems approach of identification and measurement of pilot tasks.

The systems approach has been successfully used to identify piloting tasks, training requirements, and performance standards in fundamental flying programs. An operational task oriented flying training program developed by the Air Force Human Resources laboratory laid the foundation for determining and measuring common flying tasks using a systems approach. This program developed the methodology to establish



the types of knowledges, abilities, and skill levels based upon an objective analysis of the types of common tasks that pilots would be expected to perform in operational situations.

The conceptual relationship of training to operational mission is shown below.<sup>8</sup>

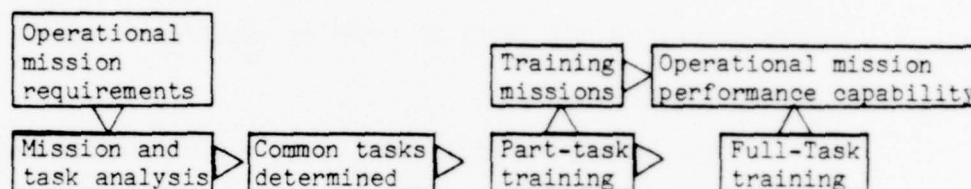


FIGURE 2. Operational Task Oriented Flying Training Program

Different piloting tasks require different types of performance, ranging from knowledge of when to initiate an action, to the required aircraft control manipulations, to recognizing a normal or abnormal operating condition. Assessment of skill level is made by comparing observed performance with pre-established performance requirement criteria. These criteria for the assessment of skill levels in air-to-air combat have not been developed into a usable systems approach format. One of the most difficult problems in air combat training is to determine the point in the training cycle at which the pilot becomes trained. The definition of "trained" required the determination of the point at which the skill, or set of skills, becomes ingrained.<sup>9</sup> This would also be valuable in determining the number of DACT missions required for DACT proficiency. According to a Rand Corporation report on pilot training, flying training can be derived from a relationship between the pilot's skill level and his degree of awareness.

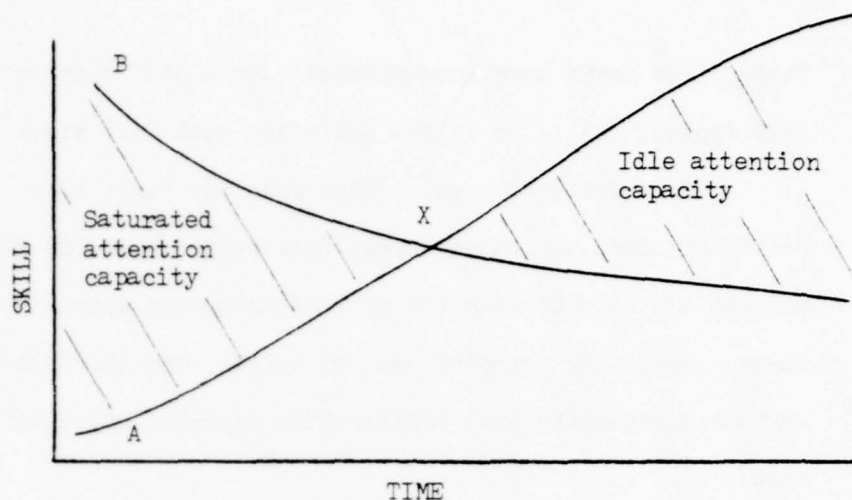


FIGURE 3. Pilot Skill Level and Awareness Relationship

As skill level (A) goes up, the degree of awareness (B) goes down. As the response becomes automatic (X), the task becomes relegated to the subconscious level and the pilot is considered trained.<sup>10</sup> The point at which a particular pilot skill becomes consistently correct can be evaluated more easily for a common pilot task than for certain pilot tasks required in air-to-air combat. Even though the outcome of the air-to-air engagement can be measured, the skill factors leading up to the outcome are very difficult to measure.

The 527th Aggressor Squadron training personnel formulated a limited set of pilot tasks to measure pilot skill in DACT. These tasks, which represent some measurable components of pilot skill considered to be "teachable," are:

1. Estimating range/aspect/nose position.
2. Engaging the enemy (maneuverability).
3. Attempting a kill (Radar/IR/Gun).
4. Ordnance fired in parameters (kill substantiated by film).
5. Use of onboard radar/fire control system.

These pilot tasks were incorporated into a DACT mission questionnaire (see Appendix C) to be filled out after each DACT mission.

The ability of a pilot regarding the first pilot task - to correctly estimate the range/aspect/nose position of the enemy aircraft - enables him to determine the most advantageous maneuver to engage the enemy. Peacetime training against larger, similar fighters followed by wartime engagements with smaller MIGs revealed pilot deficiencies in this area.

The second indicator of pilot skill is the ability of a pilot to offensively maneuver his aircraft into a position in which he has an opportunity to kill the enemy or defensively maneuver to ward off an enemy attack. The "initial move" is the most important as it will probably determine the outcome of the engagement.

Once engaged, the third indicator is a discriminator between those pilots who become engaged and do not fire a weapon and those who at least attempt a kill. The "valid kill" indicator represents the ability of the pilot to fire his weapons accurately. This tests the pilot's knowledge of the weapon system and performance envelope of his ordinance. Red Baron studies document the problem pilots in Southeast Asia had in learning and recognizing the performance envelopes of their missiles. Many were fired that apparently had no chance of hitting the target.<sup>11</sup> Also, a low percentage of gun attacks were made within the normal training envelope of less than 3,000 feet, less than 30 degrees aspect angle, and less than three G's.<sup>12</sup>

The last indicator of pilot skill to be measured is the pilots use of the radar/fire control system to acquire and fire ordinance at the enemy in a turning fight. This measures the pilot's ability to

accomplish all the steps necessary to execute difficult radar missile attacks under the pressure of close-in, high G air combat. These indicators, measured during each dissimilar mission, would not only reflect a pilot's flying ability but also his conceptual grasp of the air-to-air engagement.

Analyzation of data extracted by the author from a sample size of 300 DACT questionnaires revealed mixed results. It was anticipated that the participants would progress from the "buck fever" stage of an unfamiliar air combat situation to a level of consistently correct decisions and skills. The questionnaire confirmed the areas of expected difficulty, but measurement of these areas throughout the training did not support the expected progress. Visual acquisition ranges of the F-5E improved, but the maneuverability of the F-5E continued to cause problems. The correlation of kill attempts to valid kills showed no overall improvement. The pilot's use of the onboard radar in a turning fight showed improvement. This could be due to the increased emphasis placed on practicing switchology in the air-to-air fight.

Finally, the progression of the participants in all of these areas was not statistically proven. This was due in part to a lack of a "standard" mission as the basis of comparison. The increased complexity of each follow-on mission did not allow each task to be measured at the same level of difficulty. Other variables that affected the measurement of these tasks were the formations and tactics used on each mission.

Air combat tactics and formations also have an effect on determining the outcome of an aerial engagement and therefore should be included in an evaluation of pilot skills. The major obstacle, however, is ascertaining the effect of tactics when compounded by variables



(different type aircraft) and complexities in air-to-air combat. Some progress in this area has been made as a result of Red Flag exercises at Nellis AFB designed to help fulfill ongoing training requirements of tactical squadrons.

The Operations Analysis Branch of the 4440th Tactical Fighter Training Group has developed a method to quantify aircrew learning on composite missions by using a paired observation test technique (see example in Appendix D). This is accomplished by measuring and comparing results obtained from similar missions flown before and then after aircrews receive Red Flag training. Any significant change in the scenario or force structure between the two missions invalidates the observation results, and as a result, quantification of aircrew learning is minimal. Even though quantification data is limited, all written and oral sources documented in the course of this research agree that Red Flag type training is the best way to prepare for future conflicts.

By training against the most accurate possible representation of an adversary, the most valuable training is accomplished. It follows, that if training can be made to appear similar to combat, it will also be more effective and increase combat capability. Red Flag training is built on the idea that the greatest test of survivability occurs during the first ten missions.<sup>13</sup> If aircrews can get those critical ten missions in a "hostile" environment before going into actual combat, chances of success will increase.

## CHAPTER V

### ENDNOTES

<sup>1</sup>Kleckner, J. T., Colonel, USAF. Air To Air Fighting, Air War College Report No. 4970, Maxwell AFB, Alabama, April 1973, p. 51

<sup>2</sup>deLeon, P. The Peacetime Evaluation of the Pilot Skill Factor in Air-to-Air Combat. Rand Corporation, R - 2070 - PF, January 1977, p. vi.

<sup>3</sup>Schemmer, B. F. "USAF Fighter Crews Train Hard to Win War in TAC's Air Combat Program," Armed Forces Journal International, May 1974, p. 38.

<sup>4</sup>"You Fight Like You Train, and Top Gun Crews Train Hard," Armed Forces Journal International, May 1974, p. 25.

<sup>5</sup>Schemmer, B. F., p. 38

<sup>6</sup>"New Look at NATO Air War," Armed Forces Journal International, May 1974, p. 34.

<sup>7</sup>deLeon, P., p. 37.

<sup>8</sup>Semple, C. A. and Majesty, M. S., Lieutenant Colonel, USAF. Operational Tasks Oriented Flying Training Program For Pilot Training: The Systems Approach. Air Force Human Resources Laboratory, TR-68-4, January 1969, p. 3.

<sup>9</sup>Stewart, W. A., Chairman, Rand Symposium on Pilot Training and the Pilot Career: Final Report, Rand Corporation, R - 615- PR, December 1970, p. 20.

<sup>10</sup>Stewart, W. A., p. 32.

<sup>11</sup>deLeon, P., p. 42.

<sup>12</sup>Project Red Baron III (s), U.S. Air Force Tactical Fighter Weapons Center, Nellis AFB, Nevada, June 1974, p. 12.

<sup>13</sup>Miller, B., "USAF Simulates Soviet Defense System," Aviation Week and Space Technology, 30 May 1977, p. 43.

## CHAPTER VI

### COST CONSIDERATIONS

A serious deficiency exists in our present force structure. Air Staff studies have identified a requirement for 42 wings for a successful European conflict, and 29 wings as a minimum for prudent risk. Presently we are authorized 26 wings. According to Lieutenant General Daniel O. Graham, former Director of Defense Intelligence Agency, the Soviets are spending 50 percent more on defense than the United States. With possible future United States reductions, this situation could go from unsatisfactory to untenable. To reduce the impact of our force deficiency, the U.S. Air Force must increase its combat capability with little or no increase in costs.

The U.S. Air Force has attempted to constrain costs by improving resource management, slowing force modernization, and reducing commitments. The oil crisis of 1973 forced a 33 percent reduction in flying time for the Air Force.<sup>1</sup> The result was degradation in readiness and proficiency. The present oil crisis, coupled with the unstable situation in the Middle East, will undoubtedly continue this trend. In view of the requirement to give priority to strategic forces, it seems likely that tactical air forces will bear the brunt of future force reductions.<sup>2</sup> The problems before us are not easy to solve, but we can begin by identifying operations and procedures that cause an undue strain on energy resources. We must design equipment and training programs that encourage a more efficient use of available

resources. The costs of fighters since World War II have sky-rocketed to the point that U.S. Air Force and Navy officials may be reminded of Calvin Coolidge's advice to "let them have one airplane and take turns flying it."<sup>3</sup>

TABLE 7. Fighter Costs - World War II To Present (Current Dollars)

<u>AIRCRAFT</u>	<u>PERIOD</u>	<u>COST</u>
P-51	WWII	\$ 53,000
F-86	KOREA	183,000
F-100	'50s	804,000
F-105D	'50s	2,140,000
F-4E	'60s	2,490,000
F-14E <sup>6</sup>	'70s	20,000,000
F-15	'70s	15,000,000
F-16	'70s	10,000,000
F-18	'70s	12,000,000
F-5E	'70s	2,500,000

Air superiority fighter costs peaked with the F-14 and started downward with the F-15, F-16, and F-18, with much of the decrease in costs attributed to less sophisticated avionics and fire control systems. The F-16 and F-18 were designed as lightweight, "low-cost" aircraft, to provide a high-low mix concept of procurement. This permits the Air Force and Navy to operate a larger number of aircraft within the same budgetary resources. Once the choice of aircraft is made, we must conduct the most cost effective, productive training possible with our limited resources. If readiness is the result of training, then it follows that the highest state of readiness, and thus combat capability, is the result of realistic training.

The high combat readiness of tactical fighter units depends on a realistic adversary for continued development and improvement of tactics and air-to-air skills. Now that the Air Force is no longer a



"single" fighter service, with the F-15 and F-16 now operational, is the F-5E still needed to fill the role of the adversary?

The author examines the economic feasibility of potential Aggressor aircraft by comparing the operating costs of the F-4E, F-5E, F-15A, and F-16A in the areas of fuel consumption, depot level maintenance costs, base level maintenance costs, and spares costs for each type aircraft.<sup>7</sup> The T-38A trainer is not included in the analyses because of the lack of essential equipment listed in Chapter III. Furthermore, the T-38A is old and must have extensive wing and fuselage modifications to strengthen the aircraft. The basic unit for comparison is an 18 unit equipped (UE) aircraft Aggressor squadron with 250 flying hours for each aircraft per year.

The first consideration is a comparison of the fuel consumption of each type aircraft. Fuel costs are determined from current price lists and billings from the Defense Fuels Supply Center. The aircraft fuel cost factors (see Appendix E) for each type aircraft were used to construct the following graph.

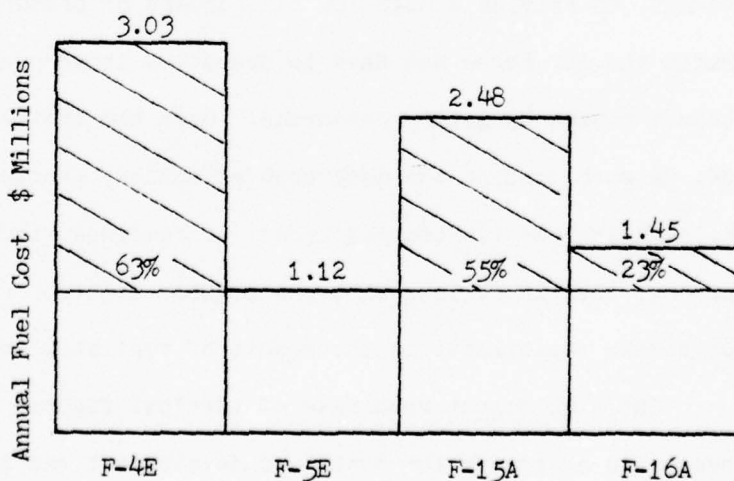


FIGURE 4. Fuel Cost of Potential Aggressor Aircraft

The F-5E uses 63 percent less fuel than the F-4E, 55 percent less fuel than the F-15, and 23 percent less fuel than the F-16. This reduced fuel consumption becomes more important as aviation fuel prices increase rapidly. Another important cost to be considered is that of depot maintenance.

The depot maintenance costs for each aircraft include civilian labor, material, overhead expenditures, and payments to contractors. Facility-related costs which reflect in-house general and administrative expenses are not included. An estimate of the annual depot maintenance costs associated with an 18 UE squadron of each type aircraft can be made using the following formula.

DM = Variable Depot Maintenance Cost Per Squadron Per Year

DM = QA + QBX

Where:

Q = Number of aircraft in squadron

A = Annualized UE cost

B = Flying hour related cost factor

X = Number of flying hours per year per aircraft

Using the cost factors for variable depot maintenance (see Appendix E), the annual expenses are:

F-4E	DM = QA + QBX	
	= (18)(67,104) + (18)(204)(250)	= \$2,125,872
F-5E	DM = (18)(8,526) + (18)(109)(250)	= 643,968
F-15A	DM = (18)(76,661) + (18)(274)(250)	= 2,612,898
F-16A	DM = (18)(50,445) + (18)(186)(250)	= 1,745,010

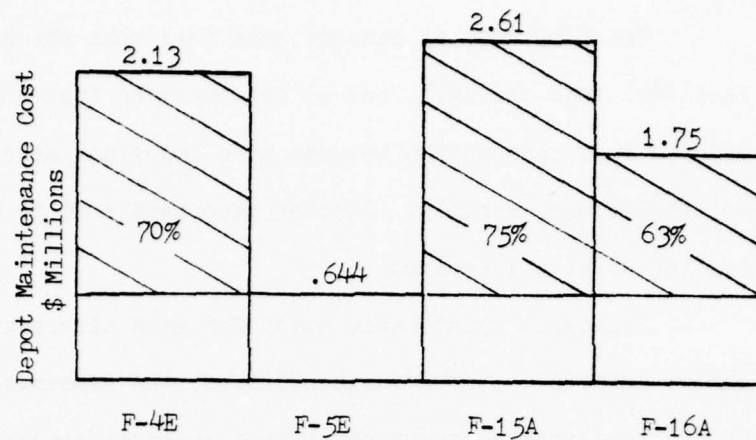


FIGURE 5. Depot Maintenance Cost of Potential Aggressor Aircraft

The bar graph visually depicts the comparison of depot maintenance expenses, showing the F-5E again considerably less than each of the other aircraft.

Another important element of the maintenance function is the base level maintenance operation. Base level maintenance factors, based on expenditure data in the Operating Budget Management Report and the actual flying hours of each type aircraft, are the sum of material and labor sub-factors (see Appendix E).

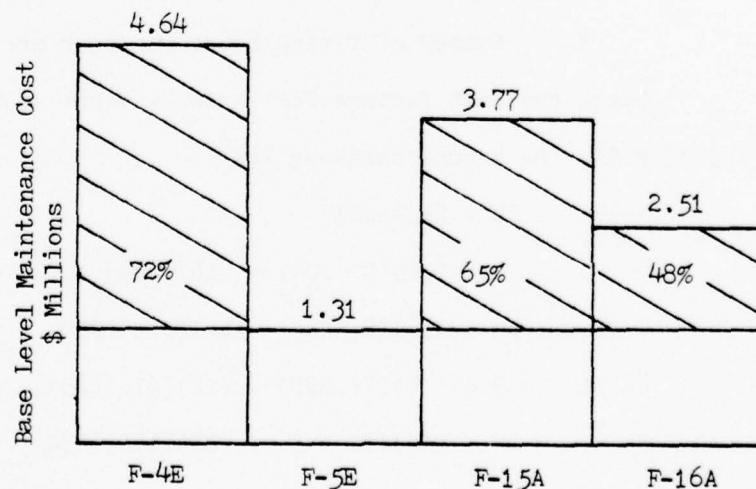


FIGURE 6 Base Level Maintenance Cost of Potential Aggressor Aircraft

The base level maintenance costs are considerably less for the F-5E than any of the other aircraft. This is to be expected because the F-5E has none of the more sophisticated avionics.

High cost repairable items must also be considered in order to complete the maintenance factors needed for cost comparison. Replenishment of spares cost estimating factors (see Appendix D) are used to analyze typical squadron operating costs and weapon system comparisons. These factors include costs for replacement of condemnations, obsolescence, and those costs generated by modifications. Use of replenishment spares cost factors result in the following graph.

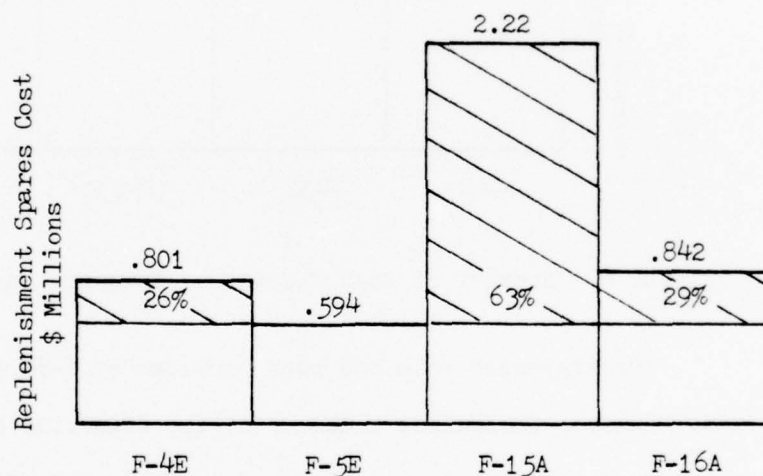


FIGURE 7. Replenishment Spares Cost of Potential Aggressor Aircraft

This graph completes the comparisons of the aircraft in the cost considerations of fuel, maintenance, material, and labor. None of the aircraft - the F-4E, F-15A, or F-16A - demonstrated a lower cost factor in any of the areas analyzed. How does all this add up in annual costs for an 18 UE squadron?



The final comparison shows the annual total cost of an 18 UE squadron with a summation of the areas analyzed. The summary of cost factors, in fiscal 1977 dollars, demonstrates that the F-5E is the most economical choice for the Aggressor role.

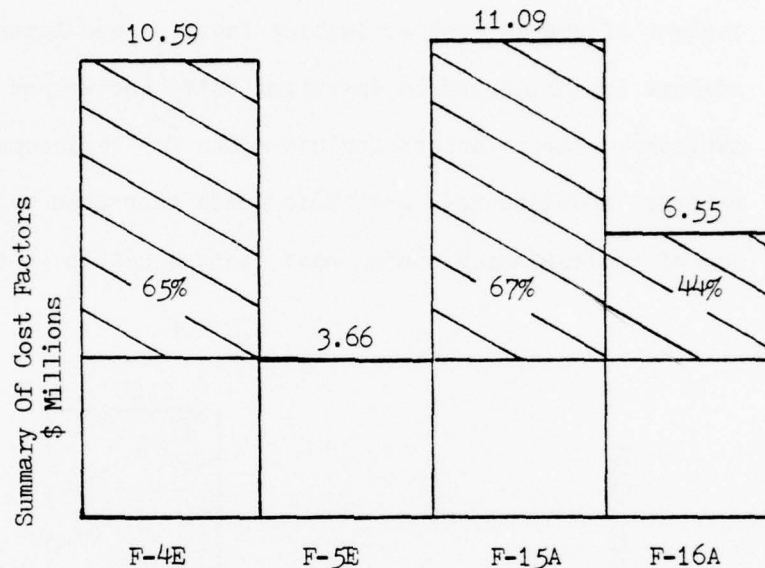


FIGURE 8. Summary of Cost Factors of Potential Aggressor Aircraft

The Aggressor role has been provided by F-5E aircraft since 1975. Senator Goldwater, a member of the Committee on Armed Services, once stated that the Aggressor squadron is "a very fine thing" and it "should remain a permanent part of the Air Force curriculum."<sup>8</sup> However, present Aggressor resources are insufficient to provide all the DACT required by tactical fighter units, and according to Major General James B. Currie, Director of Programs, DCS/P&R, the U.S. Air Force has no plans to buy any more of the aircraft for Aggressor squadrons. At the present time the ratio is one Aggressor F-5E for 32.5 tactical fighter aircraft. The Air Force has a 74 UE Aggressor

force and a tactical fighter force comprised of 1,668 UE in the Active Force and 740 UE in the Reserve Forces.<sup>9</sup>

The F-5E Aggressors can provide only 50 percent of the DACT support required by 16 air-to-air squadrons and 50 air-to-surface squadrons worldwide. However, full utilization of available Aggressor resources can contribute the most to our combat readiness for the least expenditure. A study conducted at Nellis AFB concluded that, because of the relative operating cost of the F-5E and F-4/F-15, there is a net savings of \$760 each time an F-5E flies a DACT sortie at a host F-4 or F-15 unit.<sup>10</sup> This includes airlift costs, deploy, redeploy costs and per diem costs. If the current DACT deployment capability (1,130 sorties per month) is projected to an annual total, there would be a net annual savings of over \$10 million in aircraft operating costs.

This annual savings, however, is small compared to the savings a General Accounting Office (GAO) report said was possible if flying hours were reduced by 25 percent and replaced with simulator hours. A simple calculation shows that if the sixteen air-to-air squadrons reduced their combined 72,000 hour annual program by 25 percent at approximately \$2100 per hour, a savings of \$37,800,000 would result.

A closer examination reveals an important fact that flying hour costs are high principally because of the manpower required to generate a flying hour. If the advertised savings were to be realized, our maintenance manpower would also have to be reduced by the same amount. But manpower can be reduced only to the point where wartime and peacetime mission requirements meet. Unlike the strategic forces, tactical fighter forces have a wartime sortie rate that is greater

than the peacetime rate.<sup>11</sup> Maintenance manning is based on wartime requirement, so the manpower reductions that make up much of the savings tied to flying-hour costs will not be made. Tactical fighter units do not, then, offer the savings that can be achieved by strategic airlift and bomber commands through the use of simulators.

Simulators can and should be used to enhance pilot skills. Flight simulators can be used effectively for basic pilot proficiency skills and procedures, but can simulators replace the aircraft in air-to-air combat? Sophisticated simulators have been designed to provide some degree of air-to-air simulation, but there are two major drawbacks. First, the Air Force became interested in flight simulation as a concept for savings. The McDonnell Aircraft (MCAIR) simulator with one pilot contracts at \$1200 per hour, more than an actual flying hour in an F-5E. Second, simulator learning without the threat of physical harm may lose something in terms of the pilot's total capability to cope with future stressful demands on him. Learning to react properly under stress is one of the most important factors in air combat, and the author contends that the stressful situation cannot be simulated properly in a non flying environment. So, even though flight simulators can enhance pilot skills, their application to air-to-air combat is limited and expensive at the present.

Many military and civilian studies have also explored the applicability of Remotely Piloted Vehicle (RPV) systems to modern aerial combat. RPV's are economically ideal for penetrating and operating in hostile environments where high loss-rates might prohibit operations by manned aircraft. Programmed flight patterns for

reconnaissance, defense suppression, and strike missions have been successful. However, existing technology does not permit the duplication of the functions required for successful air combat. The victor in air combat must have the capability to create or act upon unprogrammed alternatives. The use of unmanned aircraft for air superiority is still in the distant future.

In conclusion, the F-5E aircraft and the Aggressor concept of training cannot be matched by any other aircraft or method of training. The F-5E aircraft is unequalled by any aircraft in fuel economy, maintenance economy, lack of smoke trail, low radar reflectivity, and difficulty of visual acquisition. If fixed costs of the aircraft procured are included, the F-5E becomes an even more economically desirable choice. Its initial lower cost and maintainability are optimized for use in the Aggressor mission.



## CHAPTER VI

### ENDNOTES

<sup>1</sup>Jefferies, C. L., Captain, USAF. "Defense Policy in a World of Limited Resources," Air University Review, Vol XXVI, July-August 1975, p. 32.

<sup>2</sup>Long, G., Major, USAF. "Tactical Air Forces in a Period of Uncertainty," Air University Review, Vol XXVII, November-December 1975, p. 77.

<sup>3</sup>"\$100 Billion Shootout," U.S. News and World Report, January 9, 1978, p. 55.

<sup>4</sup>Gurney, G. Five Down and Glory. New York: G. P. Putnam's Sons, 1958, p. 240.

<sup>5</sup>Department of the Air Force. USAF Cost and Planning Factors (U), AFR 173-10, Vol 1, 6 February 1975, Change 5, 20 January 1977, p. A-31.

<sup>6</sup>"\$100 Billion Shootout," p. 54-55.

<sup>7</sup>"USAF Cost Factors," Table 1-Table 11, pp. A-1 - A20.2.

<sup>8</sup>Congress. Senate. Senate Subcommittee on TAC Air Power, TAC Air Program for Fiscal Year 1976, 11 March 1975, p. 4199.

<sup>9</sup>Congress. Senate. Committee on Armed Services, DOD Authorization For Appropriations For Fiscal Year 1979, 5 April 1978, p. 5236.

<sup>10</sup>Henderson, E. J., Major, U.S. Air Force, Operations Officer, 64 FWS, Nellis AFB, Nevada. Personal interview on 5 January 1979.

<sup>11</sup>Goodall, H. A., Colonel, USAF. "Simulation: A Threat to Tactical Air Power," Air University Review, Vol XXVI, November - December 1974, p. 62.

## CHAPTER VII

### SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

#### SUMMARY

A credible Warsaw Pact attack could come with little or no warning. Will history repeat itself? The outbreak of World War II, Korea, and Vietnam found the Air Force unprepared for combat, but the length of the conflicts allowed sufficient time to establish training programs geared to the war. The next war, however, may not provide the Air Force this luxury. The significant deficiencies in tactical air capability that occurred during the intervals of peace were caused partially by the failure to anticipate correctly the nature of the conflict that was to come. Any significant deficiencies that exist in today's air combat training program could result in an unacceptable outcome of a future conflict. It is axiomatic that the pilot training required to accomplish this mission is perhaps the most expensive education process in the world. The ever increasing Warsaw Pact air threat and the ever tightening budgetary constraints on U.S. military expenditures have urged a close examination of the Air Force's preparation for air-to-air combat. This thesis addressed that aim - to seek the most realistic, cost effective method of dissimilar air-to-air training, and to determine if there would be a continuing need for Aggressor Squadron training in the future.

The development of tactics and strategy of aerial combat in Chapter II was followed by the origin of the U.S. Air Force Aggressor

Squadrons in Chapter III and their current training role in Chapter IV. An evaluation of Aggressor training in Chapter V compared the air-to-air combat results of two distinct periods of the Vietnam air war - one without Aggressor training and one with Aggressor training. The outcome was projected to a possible NATO conflict to determine if there was a future need for Aggressor training. Alternate solutions to the Present Aggressor program - the F-4, F-15, F-16, and flight simulator - were investigated in Chapter VI using cost considerations as the basis for comparison.

### CONCLUSIONS

The general conclusions of this thesis are:

(1) the present Aggressor operations provide the most realistic, cost effective method of dissimilar air-to-air training available today.

(2) Aggressor squadrons equipped with F-5E aircraft will be needed through the mid 1980's.

A review of literature on quantitative analysis of the effect of pilot skills on air combat revealed the following information. An attempt by Herbert Weiss in 1966 to quantify the effects of pilot skill in air-to-air combat confused general flying experience with air combat skill, though his conclusions form the basis for some of our training programs today. Another attempt to tie peacetime pilot skill factors to wartime air combat results was attempted in 1976 by Peter deLeon of Rand Corporation, but the study was inconclusive due to the lack of critical peacetime training records. A systems approach developed by the Air Force Human Resources Laboratory laid the

foundation for determining and measuring common flying tasks, but pre-established performance criteria for the measurement of air-to-air combat skills has not yet been developed into a viable systems approach format due to uncontrollable variables and the complexity of the mission.

Research in the measurement of pilot skills to compare a pilot's air combat skills before and after completion of Aggressor dissimilar training resulted in little valid statistical data. Analyzation of pilot skills recorded on 300 DACT questionnaires produced mixed results because lack of a standardized mission did not allow each task to be measured at the same level of difficulty. The Operations Analysis Branch of the 4440th Tactical Fighter Training Group at Nellis AFB, Nevada, overcame this problem by measuring and comparing results obtained from similar missions flown before and after aircrews receive Red Flag training. Valid quantification data is insufficient at this time for any meaningful assessment.

The determination of the Aggressor squadron's effectiveness today and importance in the future was made on the Navy's significant improvement in air combat capability in Vietnam after Aggressor training was initiated. The Navy's improvement by a factor of five was accredited to the Aggressor program, and this factor projected to a future conflict revealed a substantial savings of over 50 percent in personnel and equipment. This analysis, though general in nature, indicates the necessity of a continued Aggressor program.

The F-5E in the Aggressor role has a significant advantage over the F-4, F-15, or F-16 due to fuel economy and maintenance economy. An economic comparison of an 18 UE squadron of each type aircraft



revealed the F-5E to be 44 percent more economical than the nearest competitor, the F-16. The F-5E also presents the closest visual and radar reflectivity simulation to the MIG-21, postulated to be a primary threat through the mid-1980s.

The state of art of air combat simulation by flight simulators does not justify the simulators to replace any part of the dissimilar flying program. The air-to-air flight simulators have improved immensely, but the cost per hour of operation has already exceeded the cost of an F-5E flying hour. Also, stressful situations of air-to-air combat cannot be simulated in a ground environment; the pilot must experience the stress under actual flight conditions.

Studies that have explored the applicability of unpiloted drone systems to aerial combat acknowledge that it may take considerable time for technology to reach the point where the more sophisticated air combat applications are realized. Computers cannot duplicate the functions of the human brain's ability to create or innovate unprogrammed alternatives that may be required for the success of an air-to-air engagement. Only manned systems like the F-5E can fill this role for the foreseeable future.

#### RECOMMENDATIONS

The Aggressor program should be continued within the present framework of air combat training as the focal point of enemy tactics, weapon systems and philosophy. Tactical fighter unit pilots realize an emotional benefit from training against an adversary that is not involved in their day-to-day operations. Less direct contact with the

adversary pilot reduces the feeling of comradeship and promotes the unknown that makes for a more realistic combat environment.

Serious consideration should be made to the purchase of more F-5E aircraft. The F-5E force, unequalled by any other aircraft in representing the dominant Warsaw Pact threat until at least 1985, can conduct only 50 percent of all dissimilar training required by our tactical air forces. One method that would improve tactical force readiness with minimal Air Force organizational disturbance would be to expand each Aggressor operation (with the exception of the Pacific squadron) to a 24 UE squadron. An alternate method in Europe would entail expanding the "dual base" concept of co-locating F-15s and F-16s together into a local dissimilar program.

CCTS Aircrew training records should be catalogued and retained, possibly in a computer system, to facilitate future diagnosis of training deficiencies. This would allow us to move from a traditional approach to a more objective method of measuring training.

Further studies should be undertaken to identify and establish performance requirement criteria for all aspects of air-to-air combat training that can be used in skill level assessment. Air-to-air flight simulators could be useful in measuring these skills with a pilot "flying" against a "canned" or programmed mission. A standardized grading system based on these programmed missions could at least provide a strong measurable foundation for the more advanced air combat missions.

APPENDIX A  
GLOSSARY OF TERMS

## GLOSSARY OF TERMS

**Aggressors:** The 64th and 65th Fighter Weapons Squadrons at Nellis AFB, Nevada, the 26th Tactical Fighter Training Squadron at Clark AB, Philippines, and the 527th Tactical Fighter Training Squadron at Alconbury, England. Their primary mission is to provide resources and expertise in dissimilar air combat training (DACT).

**Air interdiction:** Air operations conducted to destroy, neutralize, or delay the enemy's military potential before it can be brought to bear against friendly forces.

**Air superiority:** That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force.

**Conversion Course Training School (CCTS):** Conversion training into a specific weapons system from another operational weapons system of the same category. This training involves only that training required to employ the new weapons system. It does not normally include the basic procedural doctrinal training for the weapons system category.

**Designed Operational Capability (DOC):** Mission for which a unit was organized or designed.

**Red Flag:** Nickname of an exercise used at Nellis AFB, Nevada, to provide realistic combat training. A squadron size unit and its support elements deploy to Nellis for several weeks to operate in a combined air and surface threat environment.

**Replacement Training Unit (RTU):** A Major Command training unit which provides the initial operational aircraft check-out for UPT graduates that includes basic tactics and doctrine.

**Tactical Air Forces (TAF):** Term used to include all USAF commands that possess tactical aircraft including, but not limited to: Tactical Air Command, Pacific Air Forces, Alaskan Air Command, and United States Air Forces, Europe.

**Undergraduate Pilot Training (UPT):** The basic training program which trains officers to perform duties as pilots.

**Weapons System:** The total complex of equipment, skills, and techniques which together form an instrument of combat, usually, but not necessarily having an air or space vehicle as its major operational element.



## APPENDIX B

### Systems Approach Example

# SUMMARY OF A SYSTEMS ANALYSIS EXERCISE BY HERBERT K. WEISS

Drawing upon a limited number of World War I and World War II engagements, Weiss attempted to define just how critical pilot skill was. He derived the following approximation:

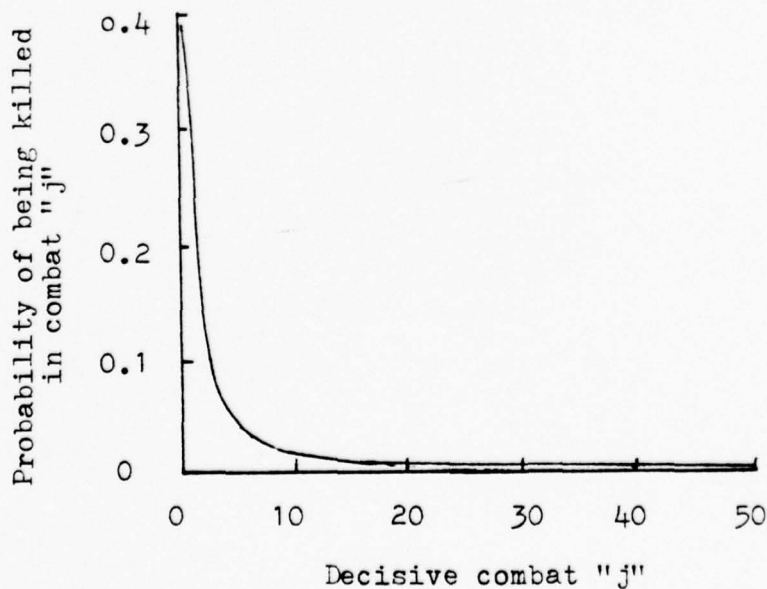
$$P_j = K_{j-1} / (S_j + K_{j-1}), \text{ in which}$$

$K_j$  = the number of pilots killed in action by enemy aircraft with some number of kills,  $j$ ;

$S_j$  = the total number of pilots living or dead with at least the score  $j$ ; and

$P_j$  = the probability that a pilot will be killed in his  $j$ th decisive combat (one in which a plane is downed).

Weiss compared  $P_j$  with the number of decisive combats and observed that a pilot's probability of living through a decisive engagement improved 20 fold from his first to his fifth mission.



APPENDIX C

DACT Questionnaire

# DACT MISSION QUESTIONNAIRE

1. DATE: ORGANIZATION:
2. TYPE AIRCRAFT:
3. PRIOR SORTIES FLOWN AGAINST AGGRESSORS: PILOTS:  
WSO:
4. TYPE MISSION (1v1, 2v1, ETC.):
5. ENGAGEMENT SETUPS (VISUAL PERCH, GCI, HEADON, ETC.):

ENGAGEMENT NUMBER 1.

2.

3.

4.

5.

6. IF YOU DID NOT HAVE A TALLY ON THE F-5 DURING ENGAGEMENT SETUP, ANSWER THE FOLLOWING CONCERNING YOUR INITIAL TALLY-HO's:

a. ENGAGEMENT NUMBER	1		2		3		4		5	
b.PILOT/WSO	P	W	P	W	P	W	P	W	P	W
c.NO TALLY-HO (NEVER SAW)										
d.RANGE-INITIAL ESTIMATE										
e.RANGE-ACTUAL, IF KNOWN										
f.THE COLOR OF THE F-5										

COMMENTS:



7. WHAT AIDS, IF ANY, WERE USED IN OBTAINING TALLY-HO's:

☐ NONE, ☐ GCI, ☐ ONBOARD RADAR, ☐ TISEO, ☐ T.D. BOX, ☐ RHAW,  
☐ SITUATION AWARENESS, ☐ OTHER CREWMEMBER, ☐ OTHER (SPECIFY).

COMMENTS:

8. RANGE/ASPECT/ANGLE-OFF OF F-5 AT VID ON TACTICAL INTERCEPTS:

a. ENGAGEMENT NUMBER	1	2	3	4	5
b. RANGE					
c. CLOCK POSITION OF F-5, & HI LEVEL, OR LOW					
d. F-5's CLOCK POSITION TO YOU.					

COMMENTS:

9. IF ONBOARD RADAR WAS USED TO DETECT/INTERCEPT THE F-5(s) ANSWER THE FOLLOWING:

a. ENGAGEMENT NUMBER	1	2	3	4	5
b. PICKUP RANGE					
c. IF APPLICABLE, LOCK-ON RANGE					
d. VIS ID MADE, YES OR NO					
e. WEAPONS DELIVERED, YES OR NO					
f. IF "MI", YOUR OPINION AS TO WHY.					

COMMENTS:

10. IF ATTEMPTS WERE MADE TO USE THE ONBOARD RADAR ONCE A TURNING FIGHT STARTED, ANSWER THE FOLLOWING CONCERNING THE NUMBER OF ATTEMPTS (A) VERSUS SUCCESSES (S):

a. ENGAGEMENT NUMBER	1		2		3		4		5	
b. ATTEMPTS/SUCCESSES	A	S	A	S	A	S	A	S	A	S
c. F4 - FULL SYSTEM										
- AUTO ACQ										
- STAB OUT										
- TISEO										
d. F15 - FULL SYSTEM										
- FLOOD										
- SUPER SEARCH										

COMMENTS:

11. WHAT PERCENTAGE OF THE TIME DID ERRORS IN ESTIMATING RANGE/ASPECT/NOSE POSITION OF F5 CAUSE SIGNIFICANT PROBLEMS IN YOUR OFFENSIVE AND DEFENSIVE MANEUVERING?

	RANGE	ASPECT	NOSE POSITION
% OFFENSIVE:	_____	_____	_____
% DEFENSIVE:	_____	_____	_____

COMMENTS:

12. WHAT PERCENTAGE OF THE TIME DID THE MANEUVERABILITY OF THE F-5 CAUSE UNEXPECTED PROBLEMS IN YOUR OFFENSIVE/DEFENSIVE MANEUVERING?

% OFFENSIVE: \_\_\_\_\_

% DEFENSIVE: \_\_\_\_\_

COMMENTS:

13. KNOWN OPPORTUNITIES FOR YOU TO HAVE TAKEN SHOTS:

TYPE	FOX-1	FOX-2	FOX-3
SHOT OPPORTUNITIES			
SHOTS ATTEMPTED			
VALID SHOTS			

a. PLEASE EXPLAIN EACH MISSED OPPORTUNITY FOR A SHOT.

EXAMPLES: 2 FOX - 2 - MISJUDGED RANGE

1 FOX - 1 - COULD NOT LOCK ON

1 FOX - 3 - WRONG SWITCHES

b. PLEASE EXPLAIN ANY NON VALID SHOTS TAKEN.

EXAMPLES: 1 FOX - 2 - TOO MUCH ANGLE OFF

1 FOX - 3 - ANGLE TOO FAR AND OUT OF PLANE

1 FOX - 1 - IMPROPER SWITCHES

APPENDIX D

Example of Red Flag Quantification

#### RED FLAG QUANTIFICATION EXAMPLE

1. For analysis purposes, Red Flag quantification of composite missions has been divided into two parts; i.e., the basic mission portion (that portion dealing with primary DOC such as strike), and the portion dealing with aircraft survivability. The following information describes the quantification method used by the 4440th Operations Analysis Branch at Nellis AFB, Nevada to measure aircrew learning in Red Flag missions.
2. Quantification of aircrew learning in each Red Flag is accomplished on composite missions by using a paired observation test technique; i.e., measuring and comparing results obtained from similar missions flown before and after aircrews receive Red Flag training. These missions are normally flown on day 2 and day 10 of a given Red Flag deployment. Any significant change in scenario or force structure between the two composite missions invalidates the paired observation results.
3. The F-5 aggressor units used in Red Flag are highly trained and represent a relatively constant threat level. Because the F-5 aggressor units could not fully support both Red Flag and their other commitments, Red Flag has found it necessary to supplement aggressor forces with different types of aircraft and aircrews from other units (e.g., F-100, F-105, F-4, F-106, etc). This has created a problem in normal quantification methods because the Red threat is not constant on both days. It often consists of Red aircrews flying the same type of aircraft as the Blue Force with aircrews learning at a rate somewhat equivalent to Blue aircrews. We recognize that F-5 aggressors also continuously learn and improve in Red Flag but, because of their already high skill level, the degree is significantly less than that of deployed units and the impact on day 10 scores is considered negligible. The net result of the mixed force is that Red Force aircrews (other than F-5) are learning and improving simultaneously with Blue Force aircrews, and learning based on differential scores between the two forces is not clearly evident. This phenomenon was first reported during Red Flag 77-10, and has been monitored subsequently to evaluate its full impact on quantification results. Thus the Blue Forces do not always show improved scores on day 10 versus day 2, when their performance may have actually improved.
4. In late 1978, sufficient data were available to address the effect of a mixed Red Force (F-5s and another unit) on quantification results. Several tests were conducted comparing results obtained from trials where the Red Force was F-5s only to those where the Red Force was F-5s plus aircraft of a different type. Any effect on strike force basic mission scores was found to be negligible and undefinable (lost in the noise level). This is primarily because engagement results are not used in computing basic mission scores and because of existing ROEs, i.e., strike aircraft are not engaged during munition delivery runs. On the other hand, survivability scores for strike aircraft were found to be significantly influenced by the type of aggressor forces. These scores are



calculated using air and ground force engagement results and are weighted based on the type and number of Red and Blue Forces available.

5. To compensate for the inability of the measurement system to isolate and define both Red Force and Blue Force learning simultaneously, an adjustment function was derived based on the learning differential measured when the Red Force was all F-5s and when a mixed force was used. The present adjustment function is applicable when the ratio of F-5s to total Red Force aircraft is .5 or greater. All mixed Red Force ratios to date have fallen within this range. The following function was derived based on empirical data and is applied to adjust differential scores (day 10 minus day 2):

$$LA = LM + 14 \left( \frac{1}{R} \right) - 1$$

where:

LA = Learning in percent adjusted for the effects of a mixed Red Force

LM = Learning in percent calculated (day 10 minus day 2 scores)  
but not adjusted for the effects of a mixed Red Force

14 = A constant derived from historical data

R = The force ratio function of F-5 aggressors to the total Red Force ( $F-5s \div \text{total Red Force}$ )

6. All past quantification results where the Red Force was a mix of F-5s and a different type of aircraft have been adjusted by use of the above function. The cumulative averages shown in the example reflect this refinement. Individual trial measurements forwarded show both the learning calculated before and after the adjustment factor has been applied. Quantification results are shown with the adjustment applied to better account for the mixed aggressor force.

QUANTIFICATION RESULTS, RED FLAG 78 - 9

26 SEPTEMBER AND 6 OCTOBER 1978 MISSIONS

GENERAL COMMENTS:

1. The quantification results for the second half of Red Flag 78 - 9 are considered valid.
2. Strike, CAP, WW, and recce aircraft were all F-4s which created identification problems for the AD force on the first quantification mission, 26 Sep 1978. In part, because of the difficulty in differentiating between CAP and the associated strikers, the Red Force F-15s scored zero in survivability on 26 Sep 1978. Identification and tactics used by the F-15s improved, as shown by the results of the second quantification mission on 6 Oct 1978:
  - a. 50% increase in valid engagements by F-15s against CAP aircraft.
  - b. Reduced CAP valid engagements against F-15s by 67%.
  - c. 15% increase in valid engagements against strike aircraft by F-15s.

QUANTIFICATION MISSION RESULTS  
FOR  
26 SEP 1978 AND 6 OCT 1978

1. OPERATIONAL SUMMARY:

a. Blue Force

<u>Unit</u>	<u>Type Acft</u>	<u>26 Sep 78</u>		<u>6 Oct 78</u>	
		<u>Sched</u>	<u>Flown</u>	<u>Sched</u>	<u>Flown</u>
474 TFW	F-4D	12	12	12	12
178 TFG	A-7D	6	6	6	6
56 TFW	F-4D	4	4	6	6
VMFA 314	F-4N	6	6	6	6
366 TFW	F-111A	3	2	3	2
35 TFW	F-105G	4	4	4	4
35 TFW	F-4G	3	3	3	1
363 TRW	RF-4C	2	2	2	2
21 TASS	O-2A	3	3	3	3
319 BMW	B-52H	3	3	-	-
7 BMW	B-52D	3	3	3	3
68 BMW	B-52H	-	-	3	3
552 AWACW	E-3A	1	1	1	1
307 ARG	KC-135	2	2	-	-
92 BMW	KC-135	1	1	-	-
VMGR 352	KC-130	1	1	1	1
924 AREFS	KC-135	-	-	2	2
320 BMW	KC-135	-	-	1	1

b. Red Force, Air

57 TTW	F-5E	8	8	9	9
49 TFW	F-15A	6	6	6	6

c. Red Force, Ground

<u>System</u>	<u>26 Sep</u>	<u>% Flight Coverage</u>	<u>6 Oct</u>	<u>% Flight Coverage</u>
General Dynamics -----				
*MPS-T1 (SAM #6)	Inop	-	Inop	-
*MPS-T1 (SAM #7)	Op	100	Inop	-
*MPS-T1 (SAM #8)	Inop	-	Inop	-
*M33 (#784)	Op	100	Op	100
*M33 (#642)	Op	100	Op	100
*M33 (#516)	Op	100	Op	100
*M33 (#552)	Op	100	Op	100
*T12 (AAA)	Inop	-	Op	100
TRTG	Inop	-	Op	100
MPS-19 (AAA #107)	Op	100	Inop	-

<u>System</u>	<u>26 Sep</u>	<u>% Flight Coverage</u>	<u>6 Oct</u>	<u>% Flight Coverage</u>
AN-MPS-9 (AAA #97)	Off Range	-----		
AN-MIQ-T3 (SAM #154)	Inop	-	Op	100
AN-MPS-9 #31	Inop	-	Op	100
AN-MPS-9 #34	Op	100	Op	100
AMS (Tolicha Peak)	Op	100	Op	100
AMS (Tonopah)	Op	100	Op	100

\*Systems which have a videotape capability, a primary aid in assessing valid engagements. Systems without a videotape capability are not used for quantification data.

## 2. QUANTIFICATION SCORE:

### Basic Mission

<u>Acft/ Unit</u>	<u>Role</u>	<u>26 Sep 78</u>		<u>6 Oct 78</u>		<u>Percent Diff</u>	<u>Adjusted Diff**</u>
		<u>Points Possible</u>	<u>Percent Achieved</u>	<u>Points Possible</u>	<u>Percent Achieved</u>		
F-4D 474 TFW	Strike	3,250	95	5,760	83	-12	-2
A-7D 178 TFG	Strike	1,500	53	2,050	51	-2	8
F-4D 56 TFW	CAP						
	Ingress	4,251	31	5,814	3	-28	
	Egress	1,629	74	1,588	84	10	
	Total	5,880	43	7,402	20	-23	-13
F-15A 49 TFW	AD	7,505	30	3,951	40	10	20

## Survival

Acft/ Unit	Threat	26 Sep 78		6 Oct 78		Percent Diff	Adjusted Diff**
		Points Possible	Percent Achieved	Points Possible	Percent Achieved		
F-4D	Air	2,997	90	4,185	71	-19	
474 TFW	Ground	150	12	216	67	55	
	Total	3,147	86	4,401	71	-15	-5
A-7D	Air	1,440	69	1,859	69	0	
178 TFG	Ground	78	100	108	70	-30	
	Total	1,518	70	1,967	69	-1	9
F-4D	Air	1,530	12	2,025	15	3	
56 TFW	Ground	50	100	108	100	0	
(CAP)	Total	1,580	15	2,133	20	5	15
F-15A	Air	244	0	277	79	79	89
49 TFW							

\*\*The differential between the two trials has been adjusted to reflect the effect of learning by the mixed AD force.

3. OVERALL SCORE. Basic mission and survival scores were combined into an overall score using the weights of 2/3 and 1/3, respectively; i.e., overall score = (2/3 x % difference in basic mission score + 1/3 x % difference in total survival score).

<u>Aircraft</u>	<u>Overall Score (%)</u>
F-4D Strike	$(2/3 \times -2) + (1/3 \times -5) = -3$
A-7D	$(2/3 \times 8) + (1/3 \times 9) = +8$
F-4D CAP	$(2/3 \times -13) + (1/3 \times 15) = -4$
F-15A	$(2/3 \times 20) + (1/3 \times 89) = +43$

4. CUMULATIVE AVERAGES. Cumulative average scores (day 10 minus day 2) were computed to reflect the total quantification experience obtained to date by an aircraft task. These scores are shown below and reflect data for which two or more valid Red Flag quantification evaluations were available.

<u>Aircraft</u>	<u>Task</u>	<u>Sample Size Effective Sorties</u>	<u>Cumulative Overall Difference Score %</u>
A-7	Strike	266	+13
F-4	Strike	287	+13
F-105	Strike	125	+15
F-100	Strike	98	+17
F-15	CAP	158	+9
F-4	CAP	48	+6
F-106	AD	44	+18
F-15	AD	37	+22



APPENDIX E

Aircraft Operating Cost Factors

Aircraft Fuel Consumption and Flying Hour Cost Factors  
(FY 77 Dollars)

<u>Aircraft</u>	<u>Type Fuel</u>	<u>Gal Fuel/Hr</u>	<u>Fuel Cost/Hr</u>
F-4E	JP4	1,555	673
F-5E	JP4	575	249
F-15	JP4	1,275	552
F-16	JP4	745**	323

1. Fuel costs @ \$ .433 per gallon
2. Estimate\*\* per AFR 173-10

Aircraft Variable Depot Maintenance Cost Factors  
(FY 77 Dollars)

<u>Aircraft</u>	<u>Annual Cost Per UE</u>	<u>Cost Per F/Hr</u>
F-4E	67,104	204
F-5E	8,526	109
F-15	76,661	274
F-16	50,445	186

1. FIXED costs are excluded from these factors.
2. The UE factors reflect a nonoperating aircraft (NOA) allowance of 10% authorized squadron strength.

Base Level Aircraft Maintenance Flying Hour Cost Factors  
(FY 77 Dollars)

<u>Aircraft</u>	<u>Material Cost</u>	<u>F/Hr</u>	<u>Labor</u>		<u>Total Labor</u>
			<u>Off</u>	<u>Airman</u>	<u>Civ</u>
F-4E	257	32	726	15	773
F-5E	40	11	227	12	250
F-15	305	24	509	0	533
F-16	163	18	377	0	395

1. Material factors based on expenditure data in Operating Budget Management Report and the actual flying hours.
2. Labor costs developed by data or estimating equations provided by PRMP and ACMCA.

Replenishment Spares Flying Hour Cost Factors  
(FY 77 Dollars)

<u>Aircraft</u>	<u>Replenishment Cost Est</u>
F-4E	178
F-5E	132
F-15	494
F-16	181

1. New aircraft estimates are provided by AF/ACMCB.

Summary Of Aircraft Flying Hour Cost Factors  
(FY 77 Dollars)

<u>Aircraft</u>	<u>Fuel</u>	<u>Depot Maintenance</u>	<u>Material</u>	<u>Labor</u>	<u>Replenishment Spares</u>	<u>Total Per Aircraft</u>
F-4E	673	204	257	773	178	2085
F-5E	249	109	40	250	132	780
F-15	552	274	305	533	494	2158
F-16	323	186	163	395	181	1248

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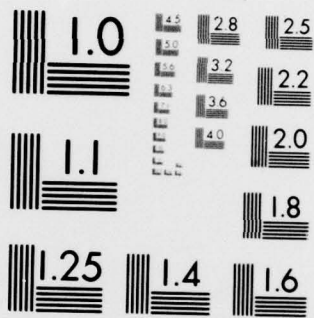
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